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THE TRANSVAAL MINES UNDER THE NEW REGIME.

By John Hays Hammond.

WITH AN EDITORIAL INTRODUCTION.

THE declaration of peace in South Africa has at last ended the paralyzing uncertainty—economic and political—which for three years has weighed upon the mining industry of the Rand. We have reached the conclusion foretold editorially in these pages in January, 1900:

"This war, springing from the struggle of the new spirit of industrial progress against the old forces of political repression . . . sooner or later, by force of arms or by sheer moral power, is certain to end in emancipation of enterprise and the freedom of engineering effort to develop to the utmost the economic resources of one of the richest mineral regions of the world."

The Boer oligarchy has disappeared, because it misinterpreted the meaning of freedom. With British rule, or colonial self-government according to Anglo-Saxon ideals, South African mining will be free to develop to the uttermost limits permitted by the natural resources of the country and the engineering methods which can be brought to bear.

The field eclipses, in interest to the world of mining engineering and mining machinery, any other region on the earth. For a technical study of its mining geology and mining practice, reference may be made to the full study presented in THE ENGINEERING MAGAZINE by Mr. Hammond and his associates, February-July, 1898, or to Mr. Hammond's recent paper before the American Institute of Mining Engineers. We are fortunate in being able to present, in the following pages, Mr. Hammond's summarized conclusion as to the conditions and possibilities of the Rand. It is the opinion of the greatest living authority.—THE EDITORS.

THE Transvaal comprises about 120,000 square miles, and includes three important gold-mining districts—the famous Witwatersrand, and the quartz-mining districts of Lydenburg and De Kaap. The entire mineral development has taken place within thirty years, for mining in the Transvaal was prohibited up to 1868, at which time the government, being in dire financial straits, threw open the gold fields to exploration and exploitation, even going so far as to offer a bonus for the discovery of profitable mines. The resultant prospecting in the early 70's led to the discovery of quartz veins and the inauguration of mining in several parts of the Northern Transvaal. The Lydenburg district first attracted attention in 1876, when exploration of the alluvial deposits began, followed later by vein mining. The De Kaap gold fields were discovered in 1884, and the conglomerate or "banket" beds of the Witwatersrand—destined to supersede all others in importance—in 1885. In that year a small stamp battery was erected to crush quartz from a vein a few miles west of Johannesburg, and in this a crushing of conglomerate was made; but it was not until April, 1887, that a battery of three stamps was erected to treat the ore of the Witwatersrand banket. This was followed by the erection of other batteries, and the output of gold for 1887 was 23,000 ounces. For 1898, the last complete year before the war, it was 4,295,609 ounces, valued at £15,141,376, and for nine months of 1899, it was 4,008,326 ounces. There were in operation in 1898, 77 mines, which in the year produced 7,331,446 tons of ore, crushed by 4,765 stamps. They employed 9,476 whites with an average monthly wage of £26, and 88,627 native workmen receiving on an average £2. 9s. 9d. each per month. During the same year in the Lydenburg district five companies, running 137 stamps, produced 154,560 tons of ore, yielding 108,884 ounces of crude gold valued at £392,378, and in the De Kaap gold fields seven companies, running 200 stamps, produced 89,760 ounces of crude gold, valued at £314,792.

The companies ceased working in October, 1899, by reason of the declaration of war, but the late Transvaal government continued operations upon its own account in some of the richest mines up to May, 1900. In May, 1901, crushing operations were resumed by the companies themselves, though upon a very small scale, only 150 stamps being run at three mines. The number was steadily increased, and by the end of 1901, 653 stamps were running, representing 12 mines; during the eight months ending with the year, 412,006 tons of ore were milled, 238,995 ounces of fine gold, valued at £1,014,687, were produced and £415,812 were paid in dividends.

The mines of the Witwatersrand district may conveniently be classed in three groups: 1. Those of the Heidelberg and Klerksdorp districts, the former about 30 miles southeast and the latter about 90 to 110 miles southwest of Johannesburg; these collectively produced in 1898, 77,393 ounces of fine gold, valued at £319,140, of which about 5/9 was from Klerksdorp. 2. The Main-Reef series, by far the most important of all, producing 93 per cent. of the total output. 3. The Deep Levels; it is in these properties that the consolidation of claims under a single management has its most useful application. A Transvaal mining claim, 150 Cape feet wide and 400 Cape feet along the dip, confined to ground contained within vertical planes drawn through its boundaries, is obviously too small to permit of profitable working as a separate unit. Companies are therefore formed by the amalgamation of a number of claims—usually 30 to 60 on the outcrop, 150 to 250 in the first row of deep levels, and a larger number still in the second row of deeps.

The Main Reef series is situated on the southern slope of the Witwatersrand, a ridge of quartzite situated just north of the town of Johannesburg and extending in an easterly and westerly direction. This ridge has a general elevation above the country to the south of from 300 to 500 feet. It is nearly 6,000 feet above sea level, and forms the watershed between the Atlantic and the Indian oceans.

In ascending order, the following are the most important conglomerate beds in the Main Reef series: 1, the Main Reef; 2, the Main Reef Leader; 3, the South Reef. The Main Reef, which gives its name to the series, consists generally of several beds of "banket" separated by layers of quartzite, though sometimes forming a solid body of conglomerate as much as 12 feet in thickness. It is worked in but very few places, being of low grade, carrying rarely more than five or six pennyweights of gold to the ton, and on the average considerably less. Overlying this reef, separated by a few feet of quartzite in places and at times without any demarcation, is the Main Reef Leader. The pebbles of the Leader are usually larger than those of the Main Reef. In some of the mines the upper portions of the Main Reef are stoped in conjunction with the Main Reef Leader itself. The thickness of the Main Reef Leader varies from a few inches to about three feet. About 16 inches would represent the average width. In its value also it varies considerably, running from a few pennyweights to several ounces of gold per ton. From 30 to 100 feet or more south of the Main Reef Leader is the South Reef, varying in width from a few inches to 5 feet.

In the Main Reef series there are sometimes as many as three "payable" parallel reefs; but while these reefs may be continuous throughout a certain section, it is rare that they are all at one time payable, the pay ore being usually confined to two of them, and in some places to one only. The reefs vary in width from a few inches to 20 feet or more. The combined stoping width of the reefs worked may be stated, however, at an average of 5 or 6 feet. The matrix of the gold and the filling of the reef is chiefly well-rounded pebbles of quartz, cemented by secondary silica, and also by sesquioxide of iron and pyrites, and chloritic matter. The gold very rarely occurs in quartz pebbles, being usually confined to the cementing material of the conglomerates.

The methods of mining in the Witwatersrand district present no features specially different from those followed in the exploitation of similar deposits elsewhere. Fortunately the ground stands well, and little timbering is required—a most important consideration in a country where mining-timber is so scarce. The mines are what mining engineers would call "dry," the water being usually seepage, and varying from 50,000 gallons per day, for a shaft sunk upon the outcrop of the reefs, to less than 5,000 gallons for a shaft sunk upon the second row of deep levels, where the reefs are reached at a vertical depth of about 2,000 feet.

The amount of water available for boilers, batteries, cyanide treatment, etc., is, even in the present state of development of the industry, inadequate, and presents a difficult problem to the mine operators. The water from the mines is usually acid, and hence not desirable for boilers. The necessary supply of water is at present made up by local storage of rain water. The average rainfall in the vicinity of Johannesburg is from 25 to 30 inches per annum; but, being more or less torrential in character, and limited to a few months, it is somewhat difficult to impound. There are, however, within 20 or 25 miles of Johannesburg, other sources of water supply, which will probably be utilized in the future.

Great attention is given to the preparation of maps of the underground workings, geological sections, and plans upon which assays are plotted. In these respects the Rand practice is far ahead of that of any other country with which I am familiar.

Reference has already been made to the labor question, in statistics of the relative numbers of whites and blacks employed. The white workmen are predominantly British, though many of the important members of technical staffs are Americans; the mine and mill foremen

are usually either Americans, or British subjects who have had mining experience in America. This labor is generally below the American standard, but is rapidly improving. Manual workers on the surface and all miners except those running machine drills are blacks, and the quality of the black labor is very poor, especially on first arriving at the mines. A few months' sojourn brings them into fine physical condition, and occasionally they remain long enough to become expert miners, though it is rare to find among the "boys" great efficiency in drilling holes. Holes are located by the shift boss and fired by him. The rapidly increasing demand for labor and the obstacles interposed by the late government caused a great deficiency of native workmen, and compelled the use of a large number of air drills in stoping, to considerable disadvantage. Where the reefs are flat or small, much larger blocks of ground must be broken down than with hand drills. More dynamite also must be used—an important consideration when dynamite is as costly as it has been on the Rand, particularly under the monopoly granted to foreign concessionaires with whom leading officials of the former government were privately associated. Another disadvantage of the use of dynamite is the undue amount of fine waste, lowering the yield of ore in the battery and increasing the production of slimes.

Long transportation, and excessive railway rates heretofore charged by the South African Railways, have made mining supplies excessively high on the Rand. How exorbitant these charges were may be indicated by the charges, in pence per ton mile, given by the late Mr. L. I. Seymour in 1897 before the industrial committee of inquiry:—On the Cape Line, 2.34; the Orange Free State, 2.34; the Natal, 3.04; the Portuguese, 4.07; the Netherlands-Cape, 7.69; the Netherlands-Natal, 5.06; and the Netherlands-Delagoa, 4.27.

Generally speaking, the cost of the principal machinery, erected on the ground, will be two and one-half times its home cost. In respect of labor, cost of dynamite, and charges for railway transport, marked improvement is confidently to be expected from the change of governmental conditions.

The mining laws of the Transvaal are most excellent in character, and while the claims cover every square foot of land for an area of nearly 40 miles long by from 2 to 3 miles wide, there have been practically no conflicts over extra-lateral rights.

Notwithstanding the change in the political status of the Transvaal which will follow the recently concluded peace and final establishment of British rule, it may be confidently assumed that the main

features of the mining law of the South African Republic will be retained, and certain oppressive features of monopolies, etc., bearing with special weight on the mining industry, will be abolished. The dynamite monopoly was one that bore most heavily on the mining industry; and, according to the reports of the State mining engineer, explosives, including fuse and detonators, amounted to nearly 10 per cent. of the total working costs of the mines. Furthermore, it was impossible to obtain the proper quality for the most economical working, and often 30-per cent. or 40-per cent. gelatine had to be used in many instances where 60-per cent. gelatine would have been much cheaper. These, indeed, form no part of the mining law proper—that is, the law regulating the tenure of mining titles. It is to be expected, both in the nature of the case and in view of the declarations already made by British statesmen, that the "ancient laws and customs" of the Transvaal will be retained under British rule, as far as possible. At all events, the principles of the English common law and the immemorial precedents of English practice will undoubtedly require the determination of present rights according to the statute in force at the time of their inception. The mine operators of the Transvaal whose titles were acquired from the Republic will therefore be secured in the position thus defined.

During the eight months ending in August, 1899, after which the commencement of active hostilities interfered with the active working of the mines, the Witwatersrand produced £12,485,032 sterling. At this rate, the year's production would have been £18,727,548. As a matter of fact, it would have amounted to some 20 millions sterling, by reason of the progressive increase in the monthly production already shown during that year. Of this output 71 per cent. was derived from what is known as the central section, extending about 1.5 miles west and about 8 miles east of Johannesburg, and 24 per cent. was derived from the deep-level properties within that section. The total gold product of the Witwatersrand was 25.5 per cent. of that of the entire world. Notwithstanding the increased production of gold elsewhere, this ratio would have been more than maintained had mining operations not been interfered with by the South African war. Within one year after the resumption of mining operations, upon the scale existing immediately prior to the war, an output of gold at the rate of over 20 millions sterling annually may be reasonably estimated; and this rate of production will be steadily increased, partly by the increase in the crushing plants of some of the companies, but more especially by the starting of many of the deep-level properties

which will then reach the producing stage. Within the next three or four years, after operations have been resumed on a large scale, the annual gold production from the Witwatersrand may reach 25 millions sterling. Beyond this amount there should be a further increase, the amount of which it is impossible to estimate. In from 6 to 8 years some of the important gold producers among the outcrop companies will fall out of line, by reason of the exhaustion of their mining areas. To what extent this deficit will be counterbalanced by increased yield in the deeper-level properties cannot be as yet determined. Much depends upon the policy adopted.

In the reliability of its ore-bearing formation, the Rand is unique in the history of gold mining; but in the minds of many an exaggerated importance is attached to the persistency of payable ore bodies in strike and in dip. There is indeed considerable fluctuation in the value of the ore within the same reef, even within short distances; but a remarkably even grade of ore has been maintained since the inception of the industry. Where there has been an apparent falling off in yield per ton during any year, the fact is to be attributed rather to the working of lower-grade ores, made possible by improved economic conditions, than to a depreciation in the ore values of the reefs themselves. With the exception of the additional costs of haulage, pumping, and ventilation, there are no factors operating against mining on the Witwatersrand to a depth of at least 8,000 feet vertically. These costs will not afford any insuperable obstacle to profitable mining, provided, of course, the geological character of the deposit is not adversely changed. So reliable is the formation, from a geological point of view, as regards its mining potentialities, that engineers have felt justified in assuming the existence of payable ore at depths of 1,000 feet and more vertically beyond the extent in depth of any mining operations. Thus far the results of actual operations upon these areas have justified their position. It is estimated that for every mile in length along the course of the reefs, down to a vertical depth of 1,000 feet for the dip of these reefs, gold to the value of about £10,000,000 will be extracted. This is a conservative estimate—at least as applied to the central section of the Rand. If we assume these conditions to obtain to a depth of 6,000 feet vertically, we have the enormous sum of £60,000,000 for each mile in length. It is not unreasonable to suppose that these conditions will be maintained along most of the central section, say for a distance of 10 miles, in which case we would have an auriferous area, within practicable mining depths, containing upwards of £600,000,000 value of gold.

It is less safe to make any prediction of the gold product to be expected from the east and west sections; but it is perfectly safe to say that the output of these sections would very greatly augment the amount I have named. Messrs. Hatch and Chalmers, well-known engineers of extensive South African experience, compute the available gold from these portions of the Rand at £200,000,000.

It is impossible to predict with any accuracy the duration of mining in the Witwatersrand district, by reason, especially, of the indeterminate factor of the rate at which exploitation will be carried on. It may be observed, however, that the tendency is to exploit the auriferous areas as rapidly as possible, and that engineering methods are all adopted with that end in view. If the exploitation of the deeper levels is not delayed pending the proving of the ground lying above, but is carried on concurrently with the exploitation of the higher horizons of the reefs, the industrial life of the district will, of course, be correspondingly shortened. The working of lower-grade ores, made possible by improved economic conditions or other circumstances, would tend to increased longevity of the industry. But, were I called upon to express an opinion, I would estimate the future duration of profitable operations on a large scale in the district at less, rather than more, than 25 years.

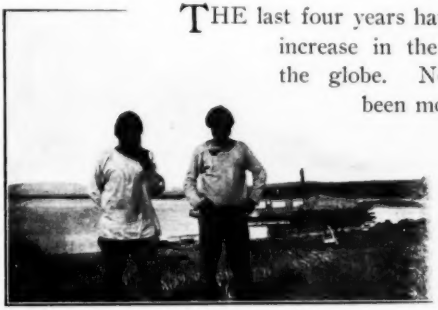
The future looks from all points of view encouraging. We may reasonably anticipate important improvements in economic conditions as the result of the establishment of a better government. I believe that, as the result of economic reforms, there will be an ultimate saving of 6s. per ton of ore treated. This refers to all savings, both direct and indirect, and especially to economy resulting from increased efficiency of labor due to the betterment of living conditions. Positions formerly commanding a salary of $15,000 a year will be satisfactorily filled for $10,000. For the tonnage of ore crushed in 1898, this would result in an increase of annual dividends of £2,199,405.

The Transvaal generally is fertile, but requires irrigation, and lack of facilities for storing water makes this at present infeasible. There is a rainy season of four or five months, between the months of November and April. The thermometer rarely reaches 95 degrees in the shade, and the heat is "dry." During the remaining winter months —April to October—rain is exceptional and there is no extreme cold. Snow is rare in the Witwatersrand. While the climate is remarkably salubrious and invigorating, the rate of mortality has heretofore been high, owing to lack of proper sanitation. Undoubtedly this will be greatly improved under better government.

THE GOLD SANDS OF CAPE NOME.

By Augustin L. Queneau.

Mr. Queneau's account of the Nome region, the character of the deposits, and the methods of mining, is written from personal experience and illustrated by his own photographs. It has the authority of expert professional knowledge and the interest of individual contact with the people and the country.—THE EDITORS.



THE last four years have been remarkable for an increase in the gold-producing areas of the globe. Nowhere has this process been more evident than in Northwest America. After the various strikes in British Columbia, came in 1897 the discoveries in the Klondyke, followed in 1898 by the great finds on the Seward Peninsula in what is called the Nome mining district. In the spring of 1900 the United States Geological Survey formed geological and topographical parties to map these newly discovered mining districts. This was in pursuance of the established policy of the Department of the Interior to help the prospectors and miners in their pioneer task. I had the good fortune to be attached to the topographical party at the head of which was E. C. Barnard, who in 1898 had mapped the "Forty Mile District." Our special task was to map a territory of about 5,000 square miles, extending from Port Clarence on the west to Golovin Bay, and reaching as far as the head waters of the Fish River and Casa de Paga to the north. Bering Sea formed the southern limit. The Bering, for its size, is the shallowest sea in the world, soundings of six to seven fathoms being very common in its whole eastern portion. It is also particularly trying for the navigator owing to the ever present fogs and the frequency of its severe storms. The sand bars of the Yukon delta extend over a hundred miles into the sea and are constantly changing their position.

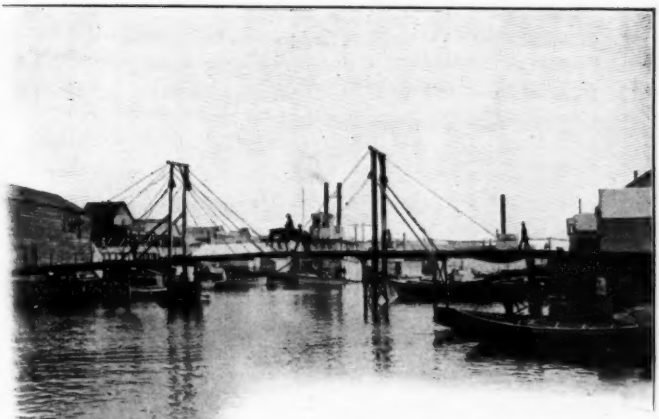
The Nome mining region includes the greater part of the Seward Peninsula. The interior is very mountainous. It is rarely, however,

that the magnificent sight of the numerous snow-clad peaks can be enjoyed, owing to the almost constant presence of fogs or of clouds which linger around the highest points. From Mount Osborn (4,860 feet) on the west to Mount Benteleven (4,600 feet) on the north, there extend, fan-like, as from central buttresses, series of mountain ranges. These enclose valleys, the rivers of which may be divided into three drainage systems, viz., Golovin Bay, Port Safety, and Bering Sea proper. These valleys are similar in character one to another, their upper portions forming narrow precipitous gorges. As the sea is approached the mountains become lower, the valleys broader, the slope less steep. Cape Nome, West Point, Cape Rodney, etc., are among the secondary promontories. A characteristic feature of the orography, the low divides between the various valleys, makes this region well-adapted for inland travel. The mountain range culminating with Mount Osborn is especially broken with divides, and is appropriately called the Sawtooth Range.

The coast has a general trend north 22° west. With the exception of a few rocky headlands, the shore is sandy and rises only a few feet above the high-tide level. At the western extremity of the district a good anchorage is afforded by Port Clarence, with Grantley Harbor at its upper end. There flows the Blue Stone. To the east the coast is difficult of approach; only small boats can cross the bars at the mouths of the Cripple, the Penny, the Snake, and the Nome Rivers. A not always reliable shelter is given by the lee of Sledge Island, some twenty miles from Port Clarence.

Port Safety lies fifty wiles from Port Clarence. It is the narrow channel of a large lagoon into which flow the Flambeau, Eldorado, Bonanza, and Solomon Rivers. Sandbars render it difficult of passage, ships of over four-feet draught not being able to enter. This lagoon has a very indented shore line and is quite shallow. The many mouths of the tributary rivers make it a veritable labyrinth of waterways, most hazardous to the uninitiated.

Thirty miles further down the coast, between two bold capes, Point Rocky and Point Derby, lies Golovin Bay which affords a good harbor. Into this bay flows Fish River with its large delta. In general the rivers have torrential headwaters, but become sluggish, deeper, and very circuitous in the coastal plain. In their meanderings their lower courses have shifted. This is true of the Snake, the Flambeau, the El Dorado, and the Fish Rivers, the old beds being marked by sluices and elongated lakes. This feature may prove of value in mining operations in this region.



BRIDGE ON SNAKE RIVER, NOME CITY.

The coastal plain is a mere stretch of marshy land or tundra, perfectly uniform in appearance, frozen or spongy according to the season, and thickly dotted with argillaceous knolls a few feet high, the so-called *"têtes de femme"* of the Canadian *voyageur*. To cross these dreary wastes, the traveler has to jump from knoll to knoll at the risk of falling into the intermediate depressions or getting entangled in the matted roots of the herbaceous or woody vegetation. The knolls arise from a gathering, during the warm period, of a soft mud of clayey material below the compact felt formed by the matted roots and peat. When the cold weather sets in, the upper crust freezes first and forces out the still liquid substratum of mud which then bursts through the covering and expands in mounds. The ground is permanently frozen below the surface. The moisture being thus prevented from filtering through, the upper strata even on the slopes of the little hills become swampy in the warm season.

The geology of the Nome Region is metamorphic. Schistose rock is the prevailing type. Gneiss and mica schists pass one to the other without sharp dividing lines. The gneiss has sometimes very thick laminations which often cause it to be taken for a granite. Hydromica schists or phyllites, hornblende schists, slates and limestones are also met with. Gold is finely disseminated in the gneiss and mica schists, but owing to the rapid rate of erosion, it has been quite easily collected in satisfactory quantities.

NOME CITY, SHOWING BOURBON AND EXTRA DRY CREEKS.

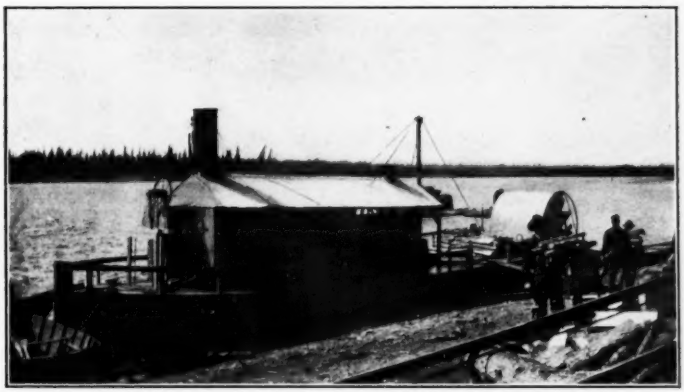
Many useful minerals have been found. In Anvil Creek platinum and iridosmin, and in Sinrock Valley small amounts of native bismuth with sulphurets rich in antimony, lead, and silver. The schists and gneiss carry large amounts of small red garnets and magnetite. Often pyrites and fine apatites are seen. There are many quartzose veins in the limestone and the mica schists. They follow in general the foliation, pinch out very suddenly, and are not highly mineralized. I remember a large quartz vein some eight feet thick having almost a vertical dip, in the mountains of the headwaters of the Sinrock. A specimen picked up showed $15 to the ton in gold with ½ ounce of silver. Dr. Cabell Whitehead of the United States Mint mentions a vein bearing $40 to the ton. These veins, however, are rare. The whole country has suffered from violent dynamic disturbances. All rocks are sheared and folded. Numerous small faults are seen where the rock is exposed, as is the case on the tops of the highest peaks. The rocks forming the Sawtooth Range, mica schists and gneiss, stand almost on edge. The strike is in general northeast to southwest and the dip to the southeast with varying angles.

Because of the schistosity and of the high dip, the moisture penetrates deeply during the warm months. This moisture in the severe weather freezes, and in expanding shatters the rock. The fragments are washed in the following spring, or carried away by the avalanches. After the great storm of September, 1900, the whole side of a mountain was laid bare by the sudden formation of an avalanche of mud

and disintegrated rock. The heavy precipitation of both snow and rain, favored by a high slope, makes the journey for the debris between the mountains and the sea comparatively easy.

The violent waves of the Bering Sea wash over the sand beach and over the sand bars, formed of the materials carried down by the rivers. A sorting action ensues, effected by the undertow and the littoral current. The minerals of high specific gravity, such as the garnet, magnetite, hornblende, and gold, resist this action much more effectively than the lighter grains of quartz, feldspar, mica, and calcite. This work varies with the velocity of the wind and its direction. Thus a section of the sea beach shows an alternation of nearly pure siliceous sand and of black iron sand. The latter in layers of one-half inch to six inches are often coated with grains of red garnet—hence the name of ruby sand given by the miners. During a violent storm a new sorting of the bars takes place with a temporary enrichment of special spots. This has given rise to the fallacious theory that the gold comes from the sea. Gold nuggets still attached to mica-schist particles have been found, leaving little doubt as to the origin of the gold.

No true bed rock has yet been found, though a hard blue or ferruginous clay some eight feet down is sometimes so called.



A STERN WHEELER AT WHITE MOUNTAIN CITY ON THE FISH RIVER.

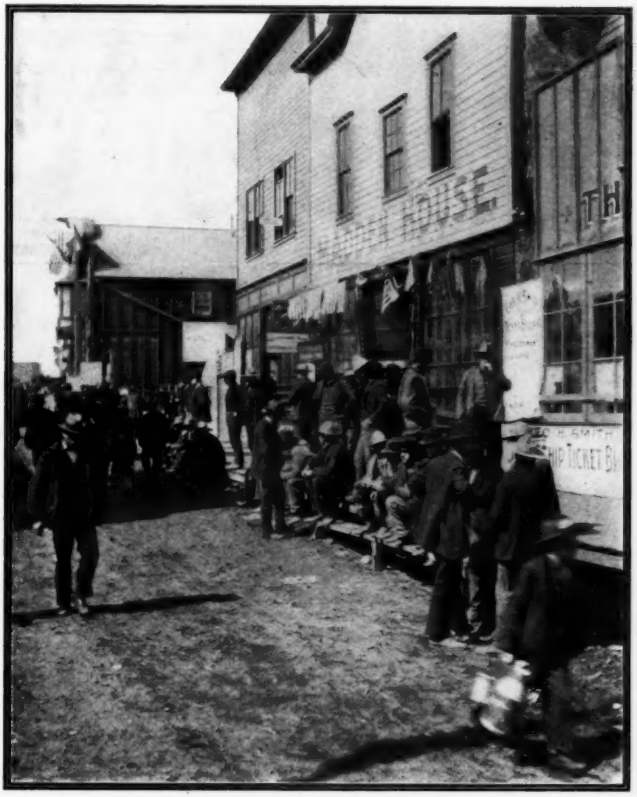
The population in the Nome Region is a floating one and very difficult to ascertain. There were in 1900 fully 40,000 people, but now not a fifth of the number remain.

Among the towns of most importance are Nome City, located at the mouth of the Snake River which divides it into two parts con-

nected by a good bridge; Fort Davis, on a sand spit at the mouth of the Nome River; Port Safety, which was utterly destroyed by the storm of September 1900, the several hundred inhabitants removing to Solomon City on the Solomon River; Tupkuk, thirty-five miles east of Nome City on the Bering Sea; Chinik, an Eskimo village and reindeer station at the entrance of Golovin Sound; White Mountain City, near the hill of that name on the Fish River—here the stern-wheelers stop to transfer their cargoes to flat boats; Golovin City, formerly Council City, on the Nukaluk near the rich placers of Ophir Creek; finally, Teller City, of considerable importance on account of the placers of the Blue Stone and Kugrock Rivers.

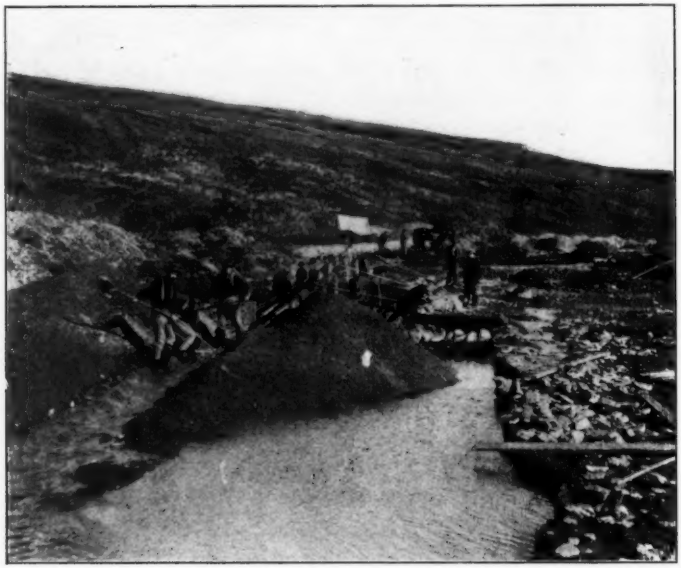
A PROSPECTING PARTY READY TO LEAVE NOME CITY.

Discovery of Gold. Up to 1898, the Seward Peninsula was visited by only a few white men, most of them being whalers, traders, or revenue-cutter men. The news of the gold finds in the Klondyke, Circle City, Forty Mile, and Eagle districts was communicated to the dwellers about Norton and Golovin Sounds and a stampede followed. A Laplander, a herder of reindeer, while roaming through the country, met Esquimaux having gold nuggets in their possession while they in-



A STREET IN NOME, AUGUST, 1900.

formed him were picked up in the Sinrock Valley. The Laplander told the story to N. C. Hultberg, a Swedish missionary, who at once formed a party to locate claims. On their way from Chinik to the mouth of the Sinrock, they were compelled to land near the present location of Nome City. At the mouth of the Snake River they found some coarse colors in the lower bars, but left without making any strikes. Later a new party, composed of Eric O. Lindbloom, Jafet Linderberg, and John Borjensen, reconnoitered the same grounds and discovered, on July 26th, what has proved to be the richest creek of the region. Lindbloom named it Anvil Creek from the peculiar shape of a neighboring mountain. They staked numerous claims on this as well



ON "NUMBER 4," BELOW DISCOVERY ON ANVIL CREEK.

as upon other creeks. After their return to Chinik they told of their good fortune and a still greater rush ensued. All the immediate vicinity was staked in the names of the stampeders and of all their friends. This was done by the use of the much abused power of attorney. The lateness of the season deferred further exploration at this time. When the winter had set in, parties with dog sleighs explored the district over an area of about one hundred square miles. Every day new comers arrived by land from the Yukon Valley. No prospecting was possible, however, through the ten feet of snow and ice. When the work was once begun the whole course of gulches and creeks was often staked by a single man with forty or fifty "powers of attorney" in his pocket. This explains the bitter outcry of 1900, when the newly arrived men were able only by an undue amount of travel in absolutely unknown land to find an acre of free ground. The claims were of the usual size, 600 by 1320.

As might be expected, most of the men relied on lucky strikes being made in their neighborhood, in order that value might be given to their holdings and thus make them marketable. Finds were not as numerous as had been expected. The whole region was thus tied up.

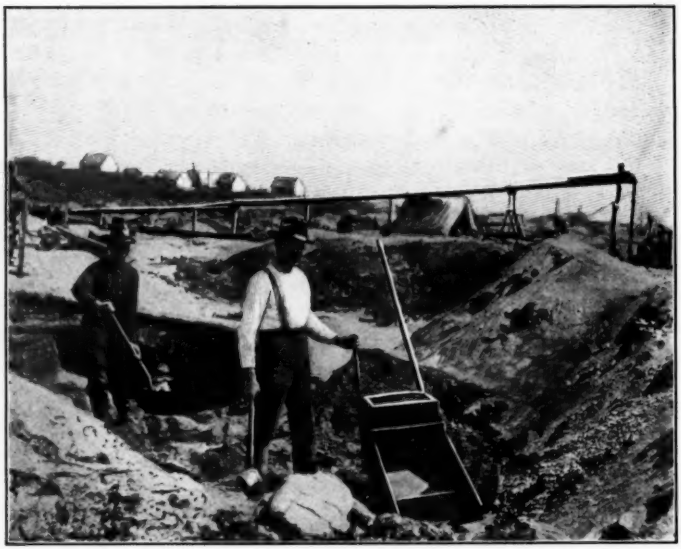
No assessment work was done. It was very difficult on torrential creeks to prove that $100 worth of work had not been done, as floods are of yearly occurrence. Only on the few creeks which from the first proved rich, such as Anvil, Glacier, Dexter, Ophir, and Dry, was work undertaken. From these large amounts of gold have been obtained. The three discoverers, who later formed the Pioneer Mining Co., were foreigners without naturalization papers and thus not entitled to hold any ground. Their claims were jumped; costly and lengthy litigation followed, which interfered with further progress.

At first, attention was given entirely to the beds of the creeks. Later the miners began to prospect the higher ground. They were rewarded by very rich discoveries near Anvil Mountain, Nikkola Gulch, etc. Here as in Klondyke, the bench claims have proved rich and will lengthen considerably the life of the camp.

Beach Gold. Up to the summer of 1899 the work was confined to the creeks and gulches. That gold was to be found on the beach was discovered by a soldier of the 7th Infantry digging for a well. The men who, unfortunate in their search, were loitering about Nome City, took up at once the prospecting of the beach all along the coast. Claims

THE NOME BEACH AFTER THE GREAT STORM OF SEPT. 5, 1900.

were staked, but owing to the wise ruling of the commanding officer of Fort Davis, no man could hold more than the ground on which he was working. When the news of these finds reached the States late in the fall of 1899 a repetition of the Klondyke craze started, particularly along the Pacific Coast. Nothing was known of the Nome country except that gold was to be had in abundance for the mere picking. Men of every walk in life pressed to Seattle, anxious for one thing to get to the northern El Dorado. Very few of them found what they had hoped for. They were, in fact, little prepared for the arduous work of prospecting. Unused to the Arctic clime, they became affected with the common disease—"cold feet." As early as June 1900 one



ROCKING ON THE BEACH.

might have seen written on the walls of stores or upon rocks such legends as this:—

"Tired, busted, and disgusted,
And a thousand miles from home."

Many lost what little money they had brought with them. Some four thousand men applied to the army posts for food, and the transports of the quartermaster department brought back many totally destitute to the States. They told frightful tales of woe. The climate was un-

healthful; the smallpox and typhoid fever were rampant; no gold was to be found. Yet many had not set foot outside of Nome City. Thus Nome's reputation fell, very unjustly, however. There is still much gold to be found there. As the unfairly staked claims are thrown open, new work will be done and many new strikes will be made. Until recently the work has been done for the greater part by

SLUICING ON THE BEACH NEAR NOME CITY.

individuals without large capital. The short working season, the distance from the base of supplies, the absolute necessity of bringing every supply from the United States, make it imperative to have large capital.

The greatest activity was displayed on the beach when fifteen hundred sluice plants were at work at one time between Cape Rodney and Tupkuk. More than half the gold was taken by rockers. The beach diggings were exceedingly pockety and some of the pockets were fabulously rich. Three men in the Tupkuk cleared $36,000 in a little over three days, working without rest on a small plot of ground.

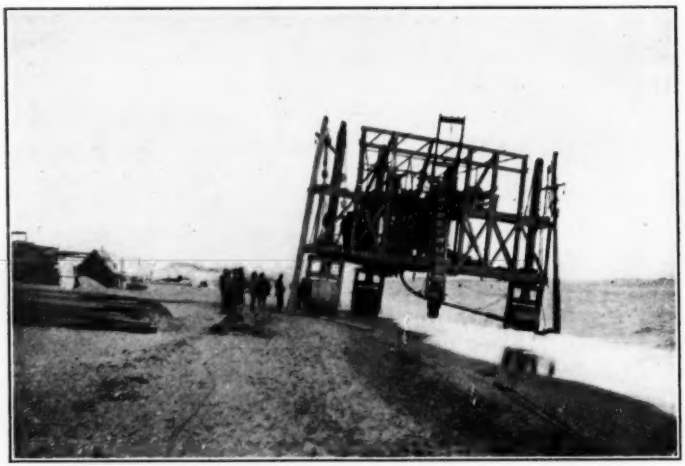
Generally two men work together at a rocker—one digs and carries the pay streak in pails to the man in charge of the rocker. The water is usually found a few feet below the surface; if not, the rocker is placed near the edge of the surf.

The sluicing requires several men. The sluice boxes are 12 feet in length, made of rough lumber spiked together. The sluice rests on a trestle 6 to 8 inches in height. Two to four men shovel the dirt. Advantage is taken as far as possible of the tundra rivulets for water. If none can be obtained, a pumping engine is installed, the water being taken from the sea. Almost every type of pump may be seen. The gasoline engine gives best results with the least outlay of expense.

The beach gold is very fine, clean, bright, and well-adapted to amalgamation. Cleaning up is done usually once in twenty-four hours, and as there is no darkness during June, July, and early August, the work goes on without stop. The clean-up is placed in a cleaning barrel and quicksilver added. As far as possible the black sand is removed by a magnet. The remaining sands, magnetites, and garnets are blown off after the drying.

Amalgamated-copper plates, or even silver-plated ones, are used in almost all plants as well as in rockers. The losses are quite large, owing to the very large proportion of flour gold. Better results would be obtained with more complete and expensive plants.

In 1899 most of the beach gold had been taken out. In 1900 the last remnants were taken. Men engaged in rocking could make a fair living—$5 to $8 per day—but most sluice plants barely paid expenses. A noteworthy exception was Tupkuk, where half-a-million was taken out in three weeks. $10,000 was taken out in 1898; in 1899, $2,000,-



A BEACH DREDGE AT WORK ON THE NOME SANDS.

A DREDGE USED AS A HOUSEBOAT ON NOME RIVER.

000, of which $900,000 came from the beach; in 1900, $5,125,000, of which $1,250,000 came from the beach. It is doubted is as much was taken in 1901, owing to various litigations.

Much the same methods are employed in all creek mining. The water is used over and over again by means of dams. The gold is coarser than the beach gold, more angular, and sometimes is coated with iron oxide, but more of this gold can be saved.

In passing a few words should be said on the dredging operations. Some dredgers have been imported, others built in Nome. All have proved failures. This is due to the shallow and rough water of the Bering Sea. On a fair day, some good runs are made on bars, but this is very exceptional. The only district which might prove suitable for dredging is Port Safety Lagoon with the numerous arms of its tributary rivers.

The greatest difficulty in the gold mining arises from the lack of, or superabundance of, water. This is especially felt in bench claims. For the Anvil Claims, Chas. D. Lane of the Wild Goose Mining Co. has plans for the creation of a central pumping plant to raise the necessary water from the Snake River. This last work would fitly crown the many enterprises undertaken by this company. They have installed telegraphic and telephonic communication between their various holdings on the Snake, the Nome, and the Nukaluk. They have built a railroad between Anvil Creek and Nome City, and have arranged for a water supply for ordinary use for fire service.

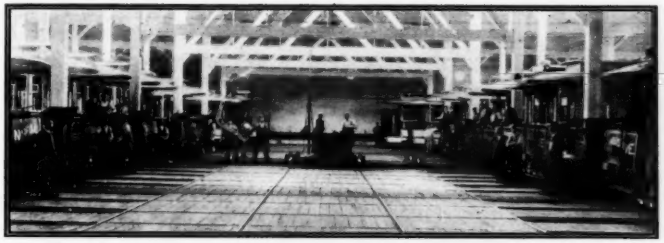
ESKIMO GRAVES.

The future success in the obtaining of Nome gold lies in hydraulic mining, when the now rich creek diggings shall have been worked out. Water in sufficient quantities can easily be collected by means of dams. In the upper parts of many creeks and rivers are to be found excellent dam sites. The building materials are to be found on the ground without any quarrying. The slope of the valleys will always afford sufficient head.

The tundra has not yet been fully prospected, but from numerous test pits sunk 20 to 30 feet deep, values from a few cents upwards to the pan have been found. The geological evidence of an emerged beach also indicates that mining here would prove valuable.

Now that the litigations which tied up the richest diggings have been settled, a bright future may be expected. Telegraphic communication is now to be had between Port Safety and St. Michael. A wireless system is also to be established. As the country becomes more developed many mineral resources will be dicovered. Good coal has already been found at Cape Lisbon and on Kotzebue Sound.

The men who are now in Nome are the men for the work. They are fully acquainted with the difficulties of the district. Experience has shown the fallacy of many theories, and henceforth mining in Nome will be conducted along the lines that have been successful in other regions.



THE MECHANICAL ENGINEERING OF AN ELECTRIC RAILWAY.

By Howard P. Quick.

The writer speaks from an experience of twelve years in the mechanical department of the West End Street Railway and Boston Elevated Railway systems, and counts it fortunate that he began his mechanical training earlier under the inspiration of that masterful machine—the steam locomotive—and started with the beginning of things in the electric-railway line at the same locomotive works in 1887, when both the science and the art were in their infancy. He considers it equally fortunate that he has witnessed the crowning achievements of 1902, not only in the development of the high-speed electric train and locomotive, but in high-powered prime movers and generators and allied apparatus and constructive methods. The illustrations are all drawn from the Boston railways mentioned above.

MUCH has been written descriptive and illustrative of the engineering features of large street-railway systems—their stations, rolling stock, lines, organization, and development. In this paper however I shall endeavor to bring out more in detail the mechanical problems met and methods used in the operation of a road, the relations of the various departments to one another, and the scope of their work, and in particular that of the mechanical departments.

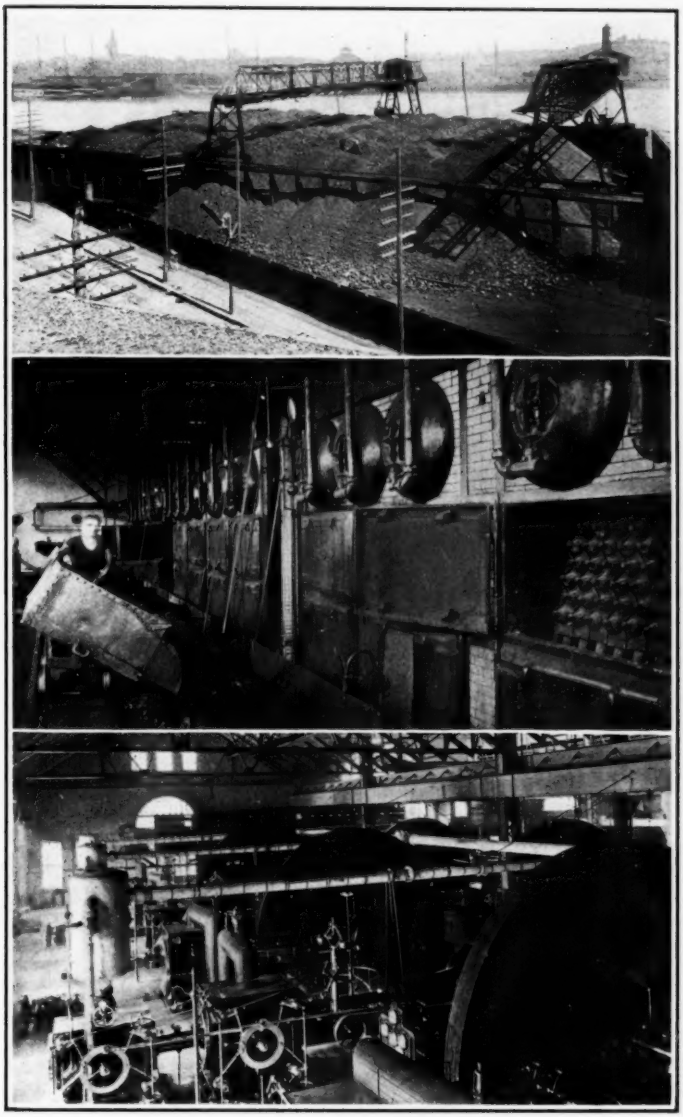
In Boston, street-railway engineering has been a gradual development and has required the constant study of a large force of trained engineers and experienced managers, who have found it necessary to originate much of the apparatus in use, have sought for machinery that they were unable to find developed to the high standard required—in fact, have been leaders in bringing manufacturers and users to a true realization of the extraordinary demands of this new force upon machinery of all kinds. And so there have been there established certain standards in materials and design which have been generally adopted in other places. It is of course understood that this line of experience is that of the direct-current type of electricity, generated by steam-

driven machines, supplied with power from coal-fired boilers, and transmitted as direct current for the propulsion of the cars.

The organization of the engineering force of a large street-railway system is very important, and perhaps no single company has an ideal arrangement. That of my company works very satisfactorily. The vice-president, who is a trained financier, is in effect the general manager and supervising or chief engineer. In some companies the latter might be the title of a distinct officer ranking with the vice-president. Under him are the heads of the different engineering departments—the mechanical, electrical, and civil, or the mechanical and electrical combined in one department under the title of "Motive Power and Machinery." The civil engineering will naturally include the architectural department and all structural engineering so called.

Under the executive engineer would of course be the superintendents of the different constructive departments, such as the superintendent of wire and conduits or of electric-line construction, the superintendent of tracks or maintenance of way, the superintendent of shops or master mechanic or master car builder, and the superintendent of buildings and building construction, plumbing, and all architectural construction. Each of these departments would have several subdivisions, handling under trained heads all the various classes of work involved.

The engineering operations of the electric-street-railway business are so largely mechanical that its management grows more and more dependent upon the executive ability and advice of the trained mechanical engineer. The electrician, civil engineer, and architect all have their spheres of usefulness, and special knowledge is required in these departments, but they require for the practical applications of their ideas many materials, tools, and devices which are purely mechanical or mechanically produced. Thus it happens that the principal and most important department will usually be the mechanical department —the department of motive power and machinery—under the leadership of a man who must be an all-around engineer—a man of tact, good judgment, and plenty of horse sense. He has under his care the design, maintenance, and control of power-station machinery, rolling stock, and all electro-mechanical apparatus. Under him are first shaped the plans which later involve the thought and labor of all the engineering departments and call into requisition the varied industrial resources of the country at large. The department of motive power and machinery is especially under consideration in this paper, and to give an idea of the magnitude of the operations involved it may be

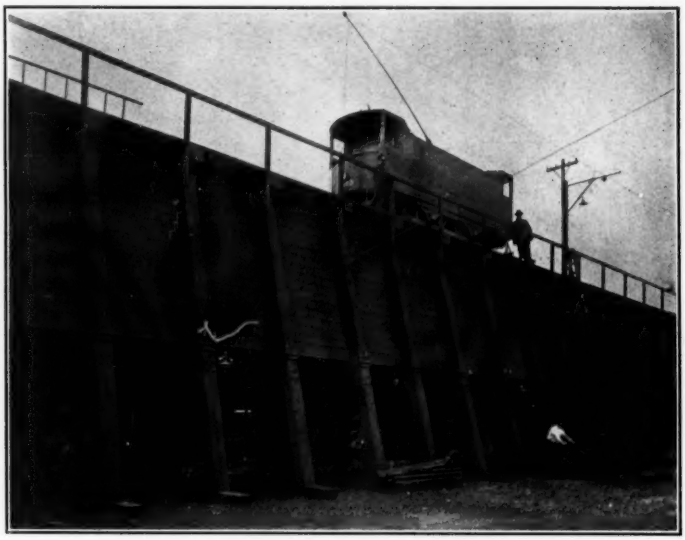


THE GENERATION OF POWER FROM COAL.

At the top is a 15,000-ton coal-storage pile, unloaded from cargo by mechanical appliances and taken to stations by electric coal cars running in tunnels under the piles. In the middle is a battery of stoker-fired boilers, to which coal is delivered by push cars raised by a log chain. At the bottom is a generating station containing 25,000 horse power of Corliss engines and General Electric direct-current generators.

well to state in detail and in round numbers the variety of apparatus controlled or maintained by the different engineering departments of a street-railway company, all depending largely on this department for maintenance and repairs. In the railway company under consideration the equipment in all departments approximates the following proportions:—

1. There are about 3,450 surface and elevated cars, both closed and open, of 9 different styles, and 300 plows and service cars. These use about 30 different styles of trucks, with a total of 4,880, and are run by 11 styles of motors, with a total of 4,420.



COAL POCKET AT AN INLAND STATION.

Supplied by 10-ton hopper cars from a distant coal wharf. The car, shown above, ascends by a spiral track.

2. There are 8 power stations, widely scattered, with 15 different styles of engines and generators ranging in power from 62 to 2,700 kilowatts nominal, making a total of 38 engines and 78 generators and more than 200 feeder machine and station panels. There are 200 different smaller machines—motors, pumps, injectors, economizers, blowers, stokers, coal hoists, etc., and 80 boilers of 6 different styles.

3. There are about 40 car houses, scattered among many cities and towns, with the usual mechanical equipment—cranes, hoists, ele-

A 25,000-HORSE-POWER BOILER PLANT.

Coal is delivered by an electric mining train from a wharf across the street.

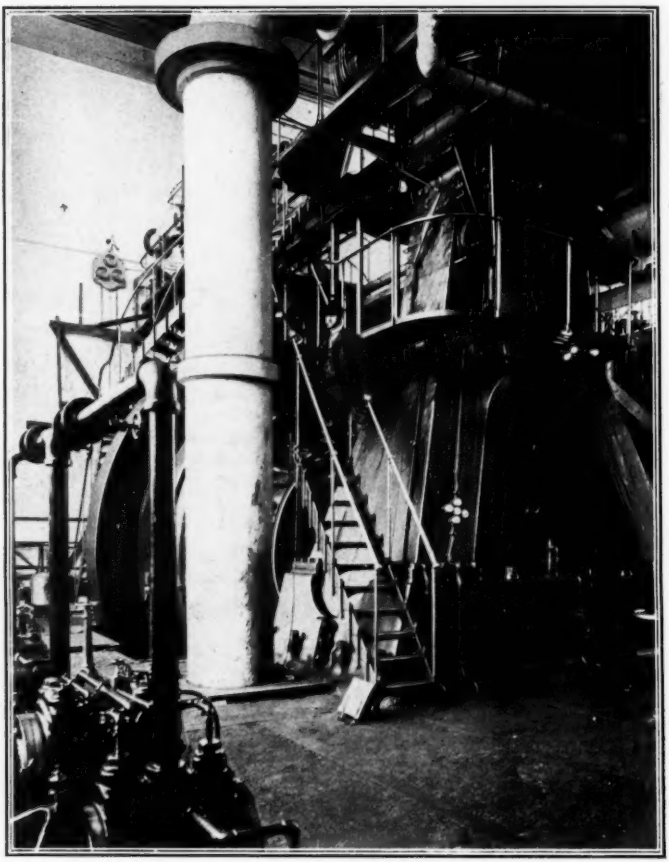
vators, transfer-tables, boilers, fire pumps, machine tools, and blacksmith apparatus, to the number of several hundred.

4. A car-manufacturing, equipment, and repair plant, with paint shops, machine, pattern, and carpenter shops, motor-repair shops, brass foundry and blacksmith shop, maintaining besides the regular car equipment that of all the other departments, including 125 stationary motors and several hundred vehicles of every description for regular and special service.

5. About 800 miles of steel rail with 1,100 miles of overhead and underground trolley and feed wire, each with a multitude of electro-mechanical devices and connections and special appliances maintained or furnished by the mechanical department.

6. A store house filled with large supplies of the many thousands of appliances, either made in the manufacturing department or supplied by outside firms and subject to the order of the various departments requiring a number of freight or service cars and the handling of a vast number of separate items monthly.

Scanning the list of apparatus enumerated above it can be seen that the design of new equipment and care of old, the repairs, changes, tests, and operations, require a very large force of men skilled by long experience with its many and various eccentricities. All railway apparatus is still in the process of evolution, and perhaps always will be, so that the new problems coming up for solution every day are manifold and



ONE OF FIVE GIANT POWER-STATION UNITS.

Vertical cross-compound engines of 8,000 horse power each, maximum, direct-connected to direct-current generators.

intricate and new devices are constantly being presented for trial or criticism.

Whatever the size of the system, the manufacturing, repairs, and equipment operations should preferably be centralized near a large power station, and usually are so placed; but if that is not convenient, a large tract of land should be secured near a waterway and railways where land is cheap and abundant, and here should be laid out a system of one- or at the most two-story buildings, convenient to trans-

fer ways, steam and street-railway tracks, and built with fire-proof materials. They should have proper sanitary, ventilating, heating, and lighting apparatus, and afford space for all the mechanical departments, draughting rooms, store rooms, lumber, and building materials. Here cars are built, equipped, and painted, and damages repaired. Trucks are constructed, overhauled, and supplied with motors. Motors are cleaned, armatures and commutators rebuilt and tested, wheels are ground, bored, and pressed on or off axles, all bearings are made or repaired, brass, copper and miscellaneous metal work is done for the different departments, registers and all electrical car apparatus are cleaned, repaired, and tested, and all general forging and pipe fitting is done. This brings the heads of all mechanical departments together where frequent conferences can be held, tests and performance of apparatus can be closely watched, progress of shop work noted, condition of supplies ascertained, and, in short, harmony of all working forces secured to the highest degree. Here may well be located, besides the mechanical engineering offices and draughting rooms, those of the lines, electrical, civil, and architectural departments, although this is not essential.

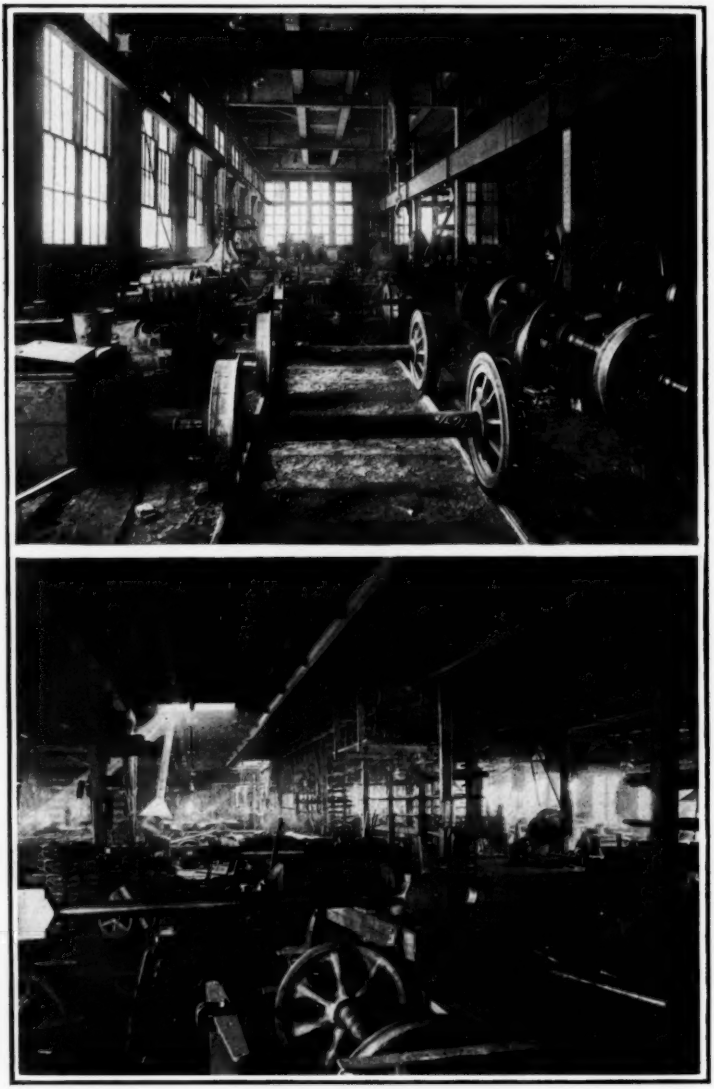
The subdivisions of the department of motive power and machinery may be:—

1. Car-motor and lighting equipment, having full charge of all new truck and motor mounting, motor and armature repairs, remounting old trucks, equipping cars electrically, care of all special and service cars, besides an electrical corps for equipment and care of stationary motors, special station electrical apparatus, electric lighting, heating, bell work, etc., throughout the system, including buildings, stations, subways, and elevated railways—all under a *superintendent of car equipment.*

2. New car construction, painting, glazing, upholstering, signing, and repair of old car bodies and vehicles of every description, with its mill room and lumber sheds, conveniently situated—under a *superintendent of car construction* or *master car builder.*

3. General minor car repairs at car houses, concerned with the daily inspection, cleaning, and handling of cars and car-house equipment, snow-plow equipment, repairs to all parts of the trucks and electrical equipment, shifting of cars and supplies—under a *superintendent of car repairs.*

4. That for manufacturing and machinery repairs, concerned with the making and fitting up of all mechanical apparatus and other devices in connection therewith, such as wood and insulating materials;



ABOVE IS THE TRUCK SHOP FOR ELEVATED CARS; BELOW, THE MANUFACTURING AND REPAIR SHOP.

The truck shop contains modern motor-driven tools, such as wheel grinders, wheel press, double-ended tire lathe, radial drill, shaper, hoists, turntables etc.; the manufacturing and repair shop builds and repairs all kinds of railway machinery, from a clock to an electric locomotive.

here are received daily orders from all over the road, embracing everything from delicate electrical instruments to 5,000-horse-power engine repairs; here are handled all car and track parts, power-station machinery, line construction, subway and elevated apparatus, and car-house appliances; this department operates the pattern and carpenter shop, brass foundry, and blacksmith shop, and has facilities for securing other castings and large forgings at various cast-iron, malleable-iron, and brass foundries and forge shops. All this work is under the supervision of the *superintendent of machine shops.*

5. Draughting, inspecting, testing, photographing and experimental laboratory work, comprising the usual draughting-room facilities, dark room, chemical and testing laboratory, with a full equipment of testing apparatus, and space not only for making indoor tests but for storage of testing apparatus, valuable instruments, specimens of tests, models, photographic plates, and chemicals—the whole in charge of an *assistant engineer*, or *chief draughtsman.* This department would of course supplement and assist those of similar nature required by the other engineering departments, each of which will have such a variety and quantity of apparatus as to require a laboratory of its own.

Having briefly described the scope of the various departments of this feature of the railway company's work, let us take up the matter of the origination and progress of orders in and through these departments, a system which requires careful planning to avoid delays, give satisfaction, and prevent friction where, as in a street-railway organization, necessities of operation require a great deal of emergency work by day and night. Such a system can hardly be the same for any two roads, but in general I believe that the final shop orders for work to be made there, as well as the requisitions for new apparatus to be supplied by purchase or contract (all of which are usually based on the department's drawings and specifications) should emanate from the draughting room by request of the chief engineer or superintendent and be accompanied by, or refer to, definite plans and specifications; after approval by this officer they should pass to the shops or purchasing department direct.

In the draughting room sufficient time could be given by clerks to the preparation of these orders, and the necessary information should be there to make them properly descriptive and accurate, referring definitely to plans or sketches and always supplemented by that kind of information.

For the purpose of information, reference, and record in the different departments involved in each particular class of work, these

orders can be duplicated or triplicated if desired and can then do their part in following the work to completion.

The value of this plan should commend itself because of the centralization and classification of data and information it permits, the records it aids to preserve in case of future duplicate orders, and the relief it affords other departments of the necessity of carrying a large stock of samples, models, irregular information, and sketches on miscellaneous scraps of paper, or of trusting to the memory of foremen or workmen. Further, it avoids any chance of shifting the responsibility for errors.

Of course, where operations are carried on night and day every day in the year in so many departments as is the case in a street-railway system, there must be a great deal of rush and night work and some special method is necessary to carry the work through properly and uninterruptedly under competent men.

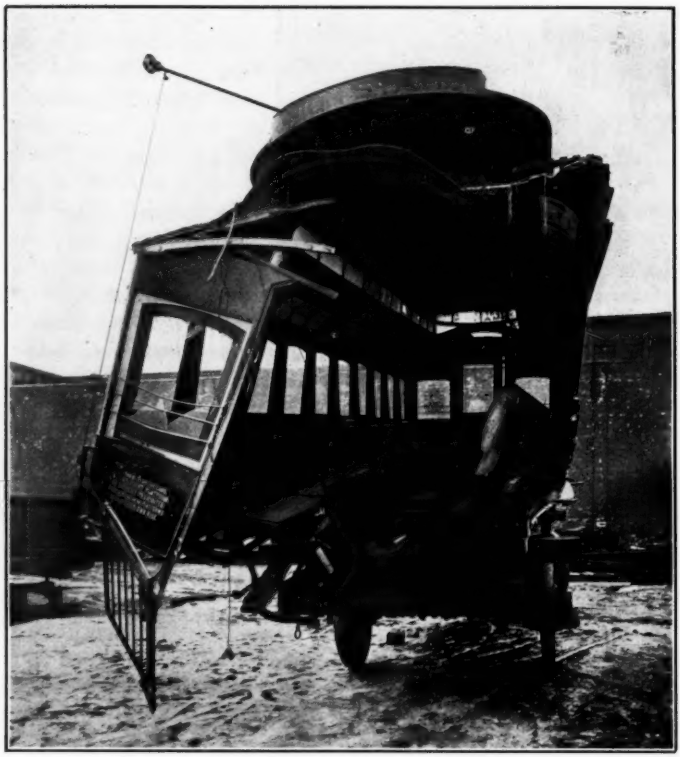
Closely associated with the matter of orders is the department of stores—an ally of the mechanical departments, though perhaps directly responsible to the purchasing department or the chief officers of the company. This store room may receive, with few exceptions, all orders for material to be supplied from stock or purchases; but these, together with all orders for drawings or repairs from the various mechanical departments, should first be seen and approved by the superintendent or his representative, and a brief notation made therefrom for reference; then the order can be transmitted direct to the store room, if the material is kept in stock or to be purchased without plans or specifications. Otherwise it should go to the draughting room for such suitable plans, sketches, data, and specifications as the superintendent may order. For example, suppose a car-house foreman or station engineer requisitions the superintendent for a number of boiler tubes of a certain size and make of boilers, with a rough sketch on his order or note. The superintendent, after receiving it, ascertains if any are in stock; if not, he transmits the order to the draughting room marked for the chief draughtsman's attention, perhaps sending a note with it. The draughting room then makes perhaps a free-hand copy-book sketch on memorandum sheets in copying ink or pencil. Then as many copies as the purchasing agent will desire may be struck off on the simplex or hektograph pads, including one in the proper copy book; or a drawing may be made in the usual way, traced and printed, and any number of prints taken. These copies are then sent to the superintendent with a new draughting-room order on the purchasing department and by the superintendent forwarded to the

THE ARMATURE ROOM, MACHINERY END.

store keeper; a duplicate of each order is kept by the superintendent while the draughting room retains a triplicate and the original order. The store keeper then requisitions the purchasing agent, retaining thereby a copy of the material with name of department and person ordering, for reference when the material is received, and with this order forwards the sketch.

To give another example; a station engineer may order a duplicate of some broken part of an engine, sending a sample, or the broken part itself, or a sketch from it with a reference to some pattern or drawing number. In any case the order goes to the draughting room and is made out anew when drawings are ready and forwarded to the manufacturing department. If a new drawing must be made and time is not sufficient for a tracing, a varnished shop sketch on small cards may be made, retaining a copy in the copy book; or if too elaborate for this size, it would be made in the form of a penciled shop drawing on larger sheets of drawing paper and sent out in this form to be traced later when time will permit. If still more time is allowed, these drawings may be traced as soon as made and sun-printed for use in the flexible form, or mounted on cards or boards of various sizes suitable for shop use. Then the order will be transmitted to the shops, calling for work from the various drawings enumerated. These will be sent for when the shop is ready to undertake the work and returned when finished. The foreman of the manufacturing department will then requisition the superintendent of motive power and machinery, the store keeper, and purchasing agent, for any material required to build the parts himself, or

ARMATURE, COMMUTATOR, AND COIL REPAIR SHOP.



A TYPICAL WRECK.

Illustrating one sort of work the shops are called upon to do.

will requisition for the whole work in case he finds he is unable to undertake it.

Another matter of importance in connection with orders is that of having the different departments order mechanical parts properly—that is, use the right name for the part wanted, its pattern number, material, and size, and refer to the machine name, number, or general type. To this end all the apparatus having a multiplicity of parts, such as cars and engines, should be studied in detail, each part given a proper designation, and tabulated with rough sketches and all the data available, in some form suitable for use by station engineers, car-house or shop foremen, store keepers, or heads of departments generally. For example, each one of the different trucks should have its parts listed on

perhaps 8 by 12 sheets of tracing cloth for multiple reproduction, showing all the castings, forgings, and non-metal parts separately. These data sheets should give a sketch, name, number per set, pattern number (either builder's or railway company's own), size, weight, and drawing number, arranged in vertical columns for ready reference. In the case of engines each size would have its list of parts arranged in a similar way, separating those for the different sizes of cylinders in case there is more than one. Another aid of considerable value would be what might be called data sheets or schedules for the various groups of standard parts, such as armature shafts and brasses, commutator segments, axles, axle brasses, wheels, boxes, brake shoes, bearings, springs, and gears, of all of which there is likely to be such a profusion that one will find the tables of great assistance. Then there are such matters for tabulation as brake mechanisms, leverages, and sizes, shoe pressures, loads on axles or at contact points of wheels on rails, general dimensions of cars and trucks with weights, and relation of cars to tracks, wires and various structures in the streets, subways, buildings, or bridges.

Every complicated mechanism should be laid out to insure accuracy in the shop work, and all departments should assist the draughting room in keeping these drawings up-to-date, not ordering changes to suit somebody's fancied discovery without having their value scientifically demonstrated.

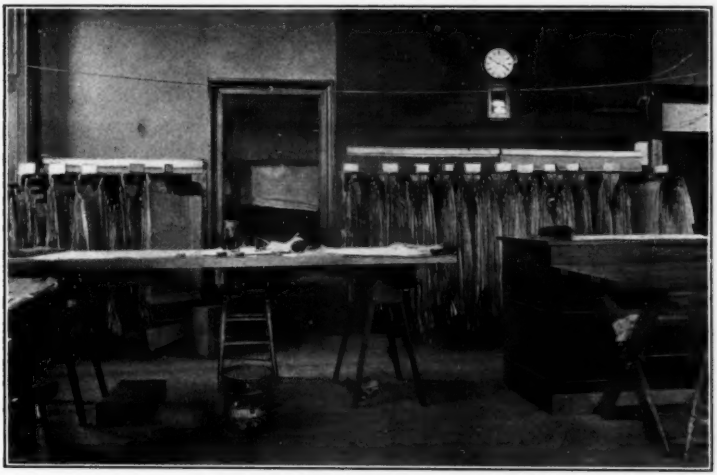
Every piece of apparatus, machine, or vehicle should have a number and a record of its location, type of equipment, dates of changes and nature of them recorded in a card catalogue. This leads us to the method of collecting and filing reports, letters, orders, data, drawings, sketches, prints, specifications, foreign plans, etc.

In the first place, it is not advisable for a department head to try to be a man-of-all-work himself. Clerical help is absolutely indispensable to the proper keeping of records, and leaves him free to carry on the more important work of his department, go over his field, and study his jobs. In the second place, records not kept up to date and down to detail are really a waste of time for perusal, and memory or a general pigeon-hole classification will better serve the purpose. Standard forms of reports of operation from the different stations, car houses, and shops are of course necessary, and these must be assembled, summarized, condensed, and tabulated for daily or weekly reports to the officials whose time is limited. For the filing of the general run of papers not larger than specification size (such as sketches, estimates, photographs, patents, catalogues, etc.), for which a subject

classification by the numerical or decimal system is sufficient, the best arrangement found by experience is to have drawers about 12 by 14 inches in cross section and 30 or 36 inches deep, modeled on the card-catalogue cabinet idea. These may be arranged in a case about three drawers high, each one pulling out full-length, supported by telescoping bars and divided by manila-card partitions, adjustable to give any width between cards. An alternative is to use a lighter drawer or slide having the so-called book-shaped letter boxes, which are about 12 by 12 inches, containing manila-paper partitions, and set on their backs with open end upwards. In either case the matter will be readily got at by using a card index to subjects, and numbers or letters in connection therewith, and it will be found to be elastic as to quantity, size, and classification.

For the larger type of records—original drawings, tracings, maps, and blue prints—different methods must be used. For tracings a method of filing which I use and recommend is that of having, in a fire-proof vault, separate drawers for each important group of machines, each station or class of station work; these drawers are about 3 inches deep, and all of the largest size required. The drawings in each drawer are arranged in sets, flat-wise, and fastened together at their right-hand edges in a paper cloth cover which serves several purposes—that of carrying a label, of keeping drawings from getting lost in a drawer, of keeping them clean, and of forming a ready means of running over the titles and numbers when searching for a particular drawing, without lifting, displacing or missing a single one. Some minor devices are necessary to facilitate keeping, handling, removing, and replacing tracings, but the method is a compact and serviceable one. Paper originals should be kept flat in drawers, arranged in similar groups and classification, and those pertaining to one job secured together. Since many of these will be traced and others are apt to be of no great value, except perhaps the general layouts, which can be kept in vaults, they may be filed in cases, where there is more space available for handling the heavier drawings than there is in a vault; so also with blue prints, which, if lost, can be duplicated from the tracings, are more often referred to and generally used, and should be even more accessible than any of the drawings. This refers to foreign blue prints as well as to home prints. There should also be blue-print copies of all tracings kept on file for daily reference, to save handling the more valuable tracings; a most satisfactory and compact method of filing these was early devised by me and has proved its efficiency by years of service. It is rather unusual and can best be understood, per-

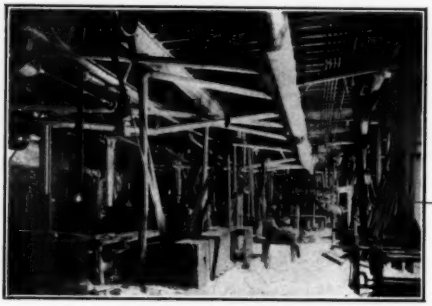
haps, by saying that it is in adaptation of the newspaper racks used in libraries and clubs. Along a blank wall space are hinged to the wall metal or wooden wings, to which sets of prints, corresponding to the tracing classifications, and fastened together by special binders, are suspended by screw eyes and hooks. The binder carries file and set number and labels; it covers the brass fastening pins and inequalities in prints and by a method of overhanging the sets on brackets enables an edgewise movement of the sets for perusal which leaves nothing to



THE MECHANICAL DRAUGHTING DEPARTMENT.

Here ideas are shaped, turned, bored and polished. The blue-print files are shown on the rear wall.

be desired. In this way many thousands of prints can be filed and reached without taking up valuable space required by other methods. A set may contain from one to seventy-five prints without inconvenience, while twenty of such sets may be hung on a wing within easy reach in a horizontal space of one foot. It is well to keep up several forms for indexing and recording drawings. One should be a system of consecutive numbers recorded in books, with all the requisite information following each number. Another should be a card index of subjects, with all classes of drawings pertaining to each subject grouped together. As to miscellaneous data, records of patterns, machines, costs, employees, stock, orders, equipment, transactions, etc., there can be no question about the advantage of a card index.



THE WOOD-WORKING SHOP.

The success of a road depends in a measure on the quality and care of the materials used in its various machines. To this end the original specifications and plans should be very complete and specific in detail and careful tests should be made of the material furnished, both during manufacture and after delivery before final payments are made. A constant watchfulness and record should be kept of the actual condition of all running machinery, wear and tear of parts, consumption of supplies, coal, oil, and waste of power, light, and heat. This requires the co-operation of the designing, purchasing, testing, electrical, and operating departments. Such questions as the economy of engines, leakages of current, electrolysis, distribution of wire, handling of coal, alignment, and condition of track and roadbed, are problems for constant study.

A railway must buy most of the machinery it uses. It may manufacture some of its cars, trucks, and small machines of which special types are required, but as a general thing its manufactured product is purchased, and all its raw material likewise, from companies making specialties of these things, reserving for the function of its shops that of finishing this raw material or of repairing machinery.

As far as possible, a railway company should have its standards, both as to quality and form of parts. The conditions vary greatly on different systems and standards are therefore not uniform. The types of apparatus developed by the street-railway company in Boston are undoubtedly the best adapted to meet the conditions. Take the rolling stock for instance:—Every part of the two standard types of surface cars and

THE PAINT-MIXING ROOM.

the elevated cars, to the minutest detail, has been the special study of certain men in the company's employ to make them not only durable machines but simple in construction so as to minimize the cost of repairs and maintenance. Their design is in a measure adapted to suit the conditions imposed by narrow streets, but great attention has been paid to the convenience and comfort of the traveling public, and the eradication of all elements of danger. Consequently the plans and specifications have been widely copied throughout the world where similar cars were wanted. The equipment is kept clean and receives an annual painting and overhauling at the company's shops.

In the matter of running gear, trucks, and motors, the company, in common with other roads, has a large variety, for this part of the equipment is still in a state of evolution. Not that satisfactory types are not built, for they are, and the company possesses some of them, and besides it has certain safeguards in the matter of standard parts which eliminate much of the wear and tear and costs of repairs due to a miscellaneous collection of these parts, such as would be furnished by different truck builders. The latter are not wholly at fault, for standards are as various almost as the different roads throughout the world are in their requirements, and of course the separate builders must vary their treatment of the same feature.

In the department of lines and wiring of every description, the wire attachments are to a large extent specially manufactured by the company and standard for the places used. These standards are the results of careful study and long experience and embrace a very complicated field with more than fifty bridges crossed, reservations, subways, inclines, and elevated railways, overhead trolley and third rail and various submarine, subterranean, and aerial difficulties to deal with. The company has a uniform car-house arrangement and equipment in the matter of the disposal of transferways, pit rooms, wash room, boiler room, and shops, and the use of a flush transfer table, motor- and axle-handling, heating, lighting, and fire-service appliances.

Operating methods and economy in operation compare favorably and agree in the main with those in other cities. Power and load distribution are still the vital question, and by their maximum concentration and pull for a few hours daily in the season of greatest travel and consumption of power, affect the life, safety, and economy, of even the best power-generating apparatus of the day. Other uses and methods of storing power at periods of light traffic demands have not yet presented an attractive field for investment to relieve station apparatus of this tremendous destructive expenditure of energy.

THE ECONOMY OF MECHANICAL STOKING.

By William Wallace Christie.

Mr. Christie's discussion is doubly appropriate in the pages of THE ENGINEERING MAGAZINE—first as it relates to practical mechanical engineering and especially the generation of power; second as it displays the application of labor-saving and intensified-production methods in the boiler room. This paper is concerned chiefly with the structural and operative features of the principal mechanical stokers. A second will take up the consideration of the general economy of machine firing, and will be illustrated with views of many important installations.—THE EDITORS.

THE small number of men to be seen in a modern large machine works or steel mill, as compared with an old-time shop of similar importance, is a matter which has been a frequent occasion for comment, and this doubtless is due to the very general use of labor-saving machinery. The cost of production in industrial establishments is made up of the costs of raw material, wages, toolage, taxes, and interest, of which the largest single item usually is the wages cost. One way by which this item may be reduced is by the instalment of mechanical stokers.

In the great majority of steam plants, the coal is wheeled to the boiler room by hand, it is fired by hand, and the ashes are removed by hand, making, in plants of 2,000 boiler horse power or over, a wages cost of some considerable amount. The familiar hand-stoker, as we know him, is not to be entirely supplanted by any mechanical device, but by its use his work can be made to cover a much greater proportion of the plant, and it will be performed with much less fatigue to himself.

The mechanical stoker may be defined as a system of grate bars, dumping bars, coal feeders, and automatic devices to feed fuel and control its combustion, and subsequently to drop the ashes and unburnt coal. That a mechanical stoker is not in any sense a new invention is to be learned from the fact that James Watt took out a patent in 1785 for a device, having for its object the getting rid of

smoke, in which the coal was placed in an upright conical tube or hopper, built in the brick work of the boiler immediately behind the furnace front, and the coal, after being coked at the front end of the grate, was automatically pushed back towards the bridge; but this stoker did not meet with much success. In 1819 John Walker, of England, brought out a furnace with a coke oven attached. Nathan Waddington's coking furnace, developed about the same time, was made up of two inclined grates, and each of the above is in part the forerunner of the Murphy stoker, as made in the United States. The mechanical stoker is therefore a device of English origin, though it has been very thoroughly developed in the United States to suit the local fuels and boiler furnace conditions.

Mechanical stokers may be classified according to the manner of their delivery of fuel to the grates as:—

a. Over-feed.
b. Under-feed.
c. Chain-grate.
d. Coking.
e. Sprinkler.

Their discussion will be taken up in order of this classification.

a. Over-feed stokers.

The two principal stokers of this type are the Wilkinson and Roney.

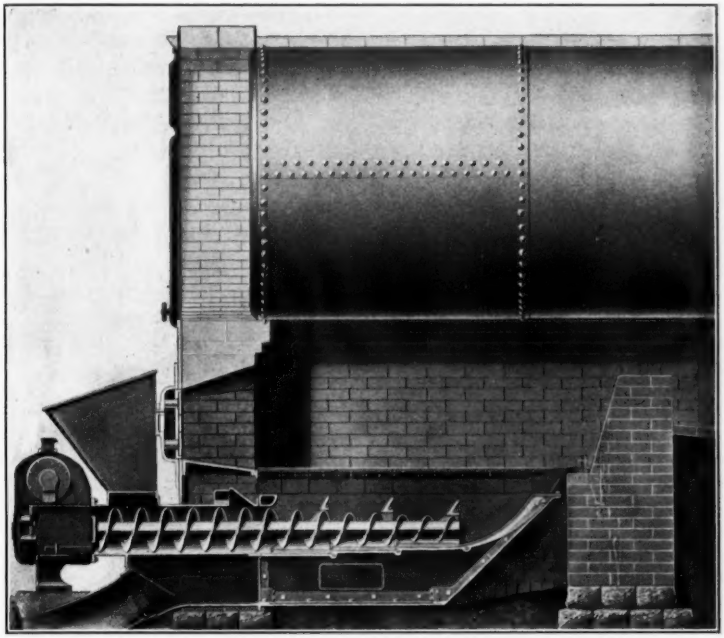
The Roney stoker consists of a hopper which receives the coal, from which it is fed by a reciprocating pusher upon a dead plate, and from there it passes to the step grates, and then to the dumping grate at the bottom or extreme end. The grate bars are made in two parts, one of which is a vertical web, the other a fuel plate which is ribbed underneath and is bolted to the vertical web, and is readily renewed. The webs being perforated, the condition of the fire can be seen at any time from the front. When this type of stoker is used for anthracite coal a special guard is provided, to retain the small coal on the grates while the dumping grate is being dropped. For bituminous coal, a coking fire-brick arch is thrown across the furnace to cover the upper portion of the grate, forming a coking furnace. This is primarily a hard-coal stoker. The Brightman and Meissner stokers are also of this general type.

The Wilkinson stoker is an over-feed stoker, in which the coal is fed from a hopper onto horizontal bars set at an angle of about 25 degrees with the horizontal. The bars on the lower ends are carried on hollow boxes, with finger bars projecting in their rear. The ad-

jacent inclined bars are moved by lever connections in opposite directions, so that the feeding is accomplished solely by this method. Steam jets with an opening of about 3/32 of an inch are placed in the upper open end of each bar to supply the air necessary for combustion. Mr. J. M. Whitman, *Trans. A. S. M. E.*, Vol. 17, page 563, states that the stoker jets used 10.59 per cent. of the power developed, the stoker engine 0.21, or a total of 10.80 per cent. Other tests gave totals of 7.83 and 10.18 per cent. When using a fan driven by a slide-valve engine he found the per cent. of power developed used to operate the fan engine was 3.21, that used to protect grate bars 5.62, and to drive stoker engine 0.25, or a total of 9.08 per cent. The engine horse power developed by the fan engine was 5.92; its steam consumption per one horse power was 76.6 lbs., and the boiler horse power developed 410.5. Steam blast is preferred for this type.

The Kincaid locomotive stoker, used in the United States, consists of four principal parts—a hopper, a trough, a stoker engine with its steam valve, and a controlling engine. The hopper bottom is like two semi-cylindrical channels, in each of which is a spiral conveyor with shafts journaled in its front and rear ends. This hopper is hinged so that it may be turned up out of the way to allow hand charging at the round house when firing up. By an arrangement of various cams, the coal, after being fed by the screws to the pocket below them, is forced varying distances along the grate. The machine, being self contained and fitted to the usual fire-door fixtures found on any locomotive, may be removed in about one minute, so that delay to trains is prevented; at the same time, by throwing up the hopper, the locomotive may be hand-fired with the stoker in position, but not so well. This stoker is said to hold up steam well, and with zero for no smoke, 100 for dense black smoke, the average when using the stoker has been 22; sparks have been reduced to 25 per cent. of those shown by other locomotives of the same class, hand-fired, with equal load behind them. A month's record on a freight train credited the stoker with saving one or two 30-ton cars of coal.

One cause of loss of economy in boilers is the constant opening of fire doors with the resulting inrush of cold air. This is especially frequent on locomotives, and is an objection easily removed by a stoker. A point that might be raised by the fireman is that his services may be rendered less valuable. I think his services would be needed all the more to think for the stoker, and besides the fact that his work as fireman is lessened and made easier, his services as engineer's assistant will be in greater demand, and of greater value.



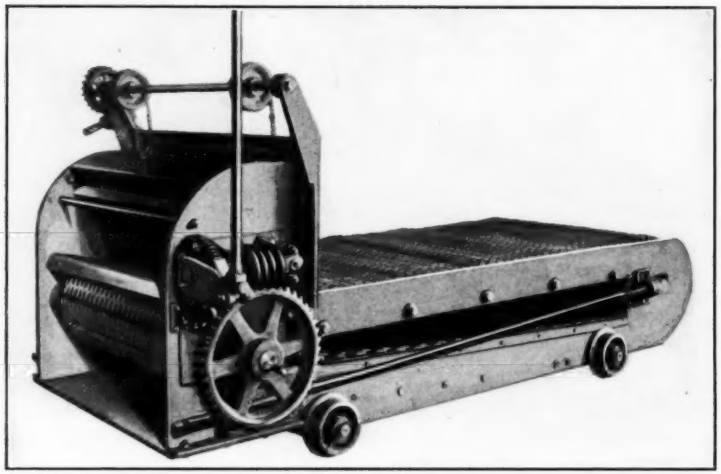
SECTIONAL ELEVATION OF AMERICAN COMPANY'S UNDERFEED-SYSTEM STOKER.

b. Under-feed stokers.

The American stoker is constructed as follows: Immediately beneath the coal hopper, and communicating with it, is a conveyor pipe, this in turn communicating with the coal magazine. A screw conveyor or worm is located in the conveyor pipe and extends the entire length of the magazine. Immediately beneath the conveyor pipe is located the wind box, having an opening beneath the hopper. At this point is connected the piping for the air supply, furnished at a low pressure by a volume blower. The other end of the wind box opens into the air space between the magazine and the outer casing. The upper edge of the magazine is surrounded by tuyeres, or air blocks, these being provided with openings for the discharge of air, inwardly or outwardly.

Each stoker is driven independently by a small steam motor, located immediately in front and beneath the hopper. The motor has a reciprocating piston. The piston rod carries a cross head, which by means of suitable connecting links, operates a rocker arm having

a pawl mechanism, which in turn actuates a ratchet wheel attached to the conveyor shaft. The stoker is thus entirely self-contained and complete in itself, and consequently there is no danger of the driving mechanism and feeding mechanism (the only working parts) ever getting out of alignment. The rate of feeding coal is controlled by the speed of the motor, this being effected by throttling the steam in the supply pipe to the motor. No special setting is required, the location of the rear bearing bar being simply changed to suit the length



DULUTH STOKER, STATIONARY TYPE.

of the stoker, and the conveyor pipe being introduced through the front. In the use of the volume blower for supplying air, the American Stoker Co. aims to deliver 150 cubic feet of air to each pound of coal burned, and with a pressure at the tuyeres of ¾ to 1½ ounces. The air required by this stoker is stated to be from 20 to 55 per cent. less than for hand firing. This stoker has been installed with success on some of the steamers of the Great Lakes.

The Jones stoker is another one of this general type and has been described as follows:—The stoker consists of a steam cylinder or ram, with hopper for holding the coal, outside the furnace proper, and a retort or fuel magazine inside the furnace, into which the green fuel is forced by means of the ram, tuyere blocks for the admission of air being placed on either side thereof; the retort contains at its lowest point, and at a point which the fire never reaches, an auxiliary ram or pusher, by means of which an even distribution of the

coal is obtained. By means of the rams, coal is forced underneath the fire, each charge of fuel raising the preceding charge upward, until it reaches the fire, which point it does not reach until it has been thoroughly coked. The gases being liberated under the fire, and at that point mixed with air, must necessarily pass through the fire and be consumed, thus giving the benefit of all combustible matter in the fuel. Air is forced at a low pressure through the tuyere blocks, under the burning fuel, by means of a blower operated by an independent engine, or from a line shaft, if such arrangement can be made. This stoker, in an adapted and improved form, is known throughout Britain as Erith's stoker.

Bodmer's stoker is made up of a single grate area between two screws; the screws, in addition to feeding the coal, give the grates a rocking motion. The helix fire feeder is a device originated and developed by Holroyd Smith.

c. Chain-grate stokers.

Among early devices was John Juckes's furnace, an English production, made up of an endless chain of bars traveling on a movable carriage. The Coxe, Playford, Babcock and Wilcox, Mansfield, Green Traveling Link, and Duluth stokers are all of the chain-grate type. Mr. Eckley B. Coxe, late president A. S. M. E., conducted extensive experiments with his stoker in connection with the utilization of small anthracite coals, and developed the machine in the most careful and scientific manner.

The furnace, as described in detail by Mr. Coxe*, consists essentially of a traveling grate moving from the right toward the left. The coal, which is brought to the hopper by a drag, spout, or any other convenient method, feeds down by gravity over the fire brick onto the traveling grate. The coal is carried slowly at the rate of from 3½ to 5 feet per hour toward the other end. In the beginning of the operation the coal on the right hand side of the furnace is ignited, the other part being covered with ashes or partially consumed coal. After the furnace is heated, the fire brick, which we call the "ignition brick," becomes hot, and the coal, passing down under a regulating gate, becomes gradually heated, and by the time it reaches the foot of the ignition brick is incandescent. In some cases the coal becomes hot enough to ignite soon after it passes the regulating gate. Under the grate there are a number of chambers made of sheet iron which are closed on all sides except on top. The blast from the fan which

* New England Cotton Manufacturers Association, 1895.

is used to furnish the air is blown into the large air chamber, the second one from the right. These air chambers are open on top, but the partitions are covered by plates. These plates are of such width that, no matter what may be the position of the grate bars, there is always one resting upon this plate, so that the air cannot pass from one chamber to another except by leakage along the bar. The result of this arrangement is that if we are blowing into the large air chamber with a pressure, say, of 1-inch water gauge, the pressure in the next air chamber to the left would be about ¾ inch, the next to that ½ inch, and the next to that ¼ inch. Of course these figures are not strictly correct, and are used merely for the purpose of illustrating, as I am now describing only the general principle of the apparatus. The pressure in the air chamber to the right would be, say ¾ inch. The result of this state of affairs is that the coal, when it arrives on the grate, is subjected to a pressure of blast sufficient to ignite it, but not so strong as to impede ignition. In order to regulate exactly the pressure of the air in each of the compartments, the partitions are provided with registers, by the simple opening and closing of which the pressure in the air chambers can be varied to suit the conditions.

As the thoroughly ignited coal passes slowly over the second compartment (where the air pressure is a maximum) it burns briskly, and then slowly passes over the third compartment, where the air pressure is less and better suited to the combustion of the thinner layer of partly consumed coal. The bed continues to diminish in carbon and to be subjected to less blast, until finally the hot ashes are cooled off (before being dumped) by a very gentle current of air, which is heated and mingles with the carbonic oxide produced in the zone of intense combustion and converts it into carbonic acid. The object is to subject the coal, as soon as it arrives on the grate, to a pressure of blast which is the proper one to ignite it, then to burn it with a blast as strong as will produce good combustion, and, as the carbon is eliminated and the thickness of the bed becomes smaller, to diminish the blast to correspond to these conditions. The mass of coal remains all the time in practically the same position and condition in which it was placed on the grate, except so far as altered by the combustion.

The Playford stoker consists of a series of grate bars hung over wheels fixed on a movable carriage placed in the boiler furnace. The water grate in the hopper is worked up and down automatically to regulate the supply of coal to the bars. Cone pulleys are used to vary the grate travel from zero to 2 inches a minute. The stoker is

operated by a ratchet feed gear, itself operated from a line-shaft eccentric. In this stoker the ashes are removed by a screw conveyor. A coking chamber, with its arch, assists very materially in producing smokeless combustion.

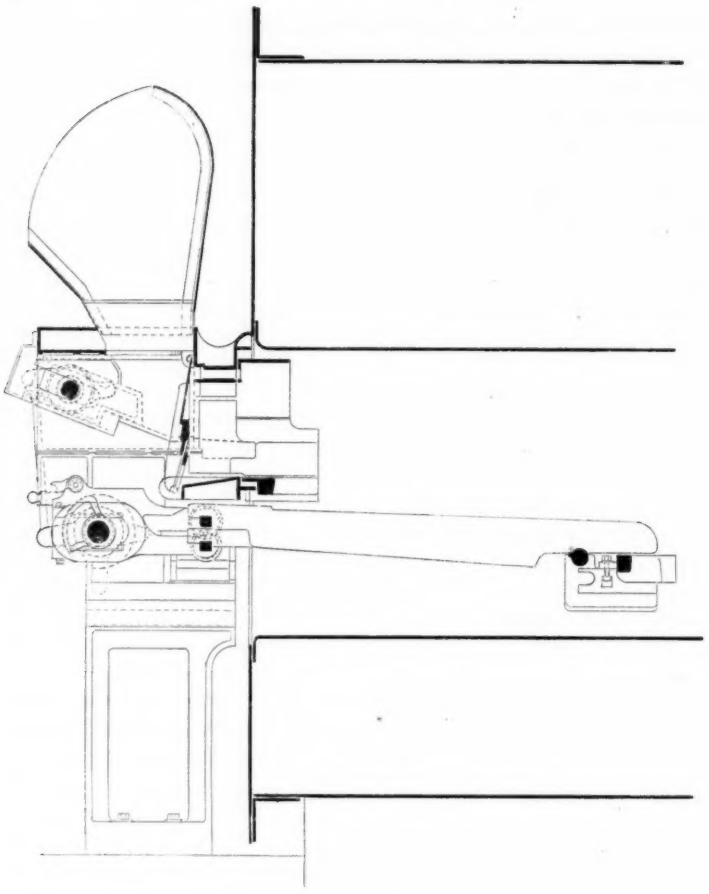
The Babcock and Wilcox, its near relative the Mansfield, and the Green Traveling Link Stokers are all of the same general type as the above. The Duluth consists in part of the Crow chain grate, and differs from others of this general type in that unburnt coal, falling through the grates, is caught up by a shoe plate and carried along on the return of the bars to the front and there dropped in front of the boiler on the fire-room floor. Eight of the largest steamships on the Great Lakes are now equipped with this stoker in successful operation.

d. Coking stokers:—

The first distinctively American stoker was patented in 1879 and is known and sold as the Murphy stoker. It is a side-feed coking stoker, chambers, called magazines, being provided in the side walls of the boiler settings the length of the furnace, into which the coal is charged and from there fed to the grate by operating the feed device sidewise, pushing the coal onto the coking table and from there upon the grate. A combustion chamber is formed over the grates by springing a fire-brick arch the full length of the furnace. A rate of combustion as high as 50 pounds of coal per hour per square foot of grate is obtained with this stoker.

T. & T. Vicars, engineers, London, E. C., write that they have discontinued publication of comparative tests, but are always prepared to guarantee the best results known to modern practice, viz: high CO_2 and low combustible in ash when burning from 10 to 50 pounds and over per square foot of grate, and from 70 to 75 per cent. efficiency with suitable boilers. This is a practice which is gaining favor among several American manufacturers. Smokeless combustion is obtained when the gas analysis shows 14 to 15 per cent. of CO_2 and an absence of CO.

The Vicars stoker is supported from ground level entirely and not hung on studs from the boiler front; it is so arranged as to clear the ordinary arrangement of boiler fittings. The upper part of the machine is fixed on rollers so that it moves backward and forwards as the boiler expands and contracts. The fuel in the hoppers falls by gravity into boxes, usually two to each furnace, from which it is gradually pushed in small quantities alternately by reciprocating rams or plungers onto the dead plate. Special arrangements are made



SECTIONAL VIEW OF THE VICARS' STOKER.
T. & T. Vicars, Earlstown, Lancs.

at this point for the rapid ignition and coking of the fuel. From the dead plate it is pushed onto the moving bars, which gradually take the burning mass further into the furnace. One of the distinctive features of this machine wherein it differs from all others is that no pretence is made of burning all the fuel on the moving grate. In fact, the speed of the bars is so regulated that there is always a layer of partially consumed coke with clinker and ash about six inches

thick, passing over the ends of the bars and discharging on the bottom of the furnace, where it banks up and forms a bridge preventing the passage of any free air into the flue, and allows very high percentages of carbon dioxide to be maintained. A bridge of brickwork is built in the flue some feet from the end of the bars, thus forming a sort of combustion chamber, and at this point the final reduction of the coke to clinker and ash takes place. At certain intervals the clinkers forming the face of the bank at the end of the bars are withdrawn, and the combustible matter brought forward to take its place and in turn be converted to clinker. With ordinary fuel the backs do not need cleaning more frequently than every five or six hours, and the furnace is still hard at work during each operation, so that the evaporation in the boiler is hardly affected at all. The supply of the fuel and the travel of the bars are regulated with facility and independently in each furnace. The coal feed is varied by altering the rate of motion of the plungers. This also applies to the motion of the bars, but the actual stroke of these can also be varied up to say four inches. The bars of each furnace are arranged in two sets, each composed of the alternate bars, and move together, traveling in towards the bridge, but return at separate intervals. Thus fuel is carried inwards by the simultaneous action of both sets of bars, and remains in place without being disturbed by the return of either set. Each successive inward movement of the bars serves to carry the fuel, together with the clinker and ash, nearly to the end of the grate, where the mass at length drops over the end of the bars as already described. On externally fired boilers the system of dealing with the coke, ash, and clinker after it reaches the end of the bars, differs. Generally speaking, however, it drops into another set of stationary inclined bars, which with the flame bridge wall form the pit or combustion chamber. There it accumulates till the pit is practically full on top with incandescent coke, and on the bottom with clinker and ash which is removed at intervals. The inclined bars can be tipped so as to remove any clinker which may have accumulated on the face, and when suitable a plate forming the base of the pit can be made to tip so as to get rid of the bottom layer of clinkers and ashes automatically. Instead of two plungers or rams, three are often used for pushing the fuel onto the bars. The brick work is so arranged that the smoky hydrocarbons are brought into contact with the incandescent portion of the fire, and meet with sufficient air at the proper moment to assist in smoke prevention. On all types of this machine the various parts receive their motion from either an overhead or underground shaft, running at

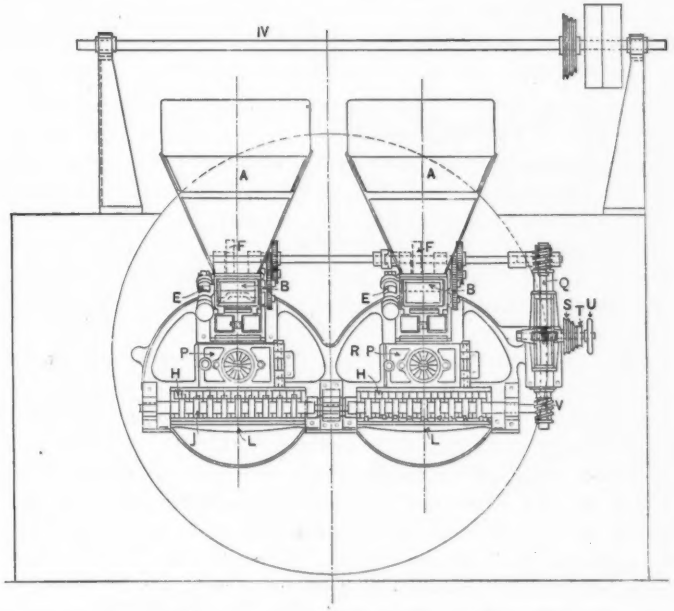
a speed of 20 revolutions per minute and invariably actuated by a small motor, engine, or adjacent shafting. There is a positive metal connection between the driving shafting and stoker ratchet wheels, and owing to the slow speed of the driving shafting the wear and tear of the moving parts is almost inappreciable. Large doors are provided which can be used for hand firing in cases of emergency. Although a portion of the unconsumed coal is delivered over the end of the bars into the combustion pits, independent tests have shown that the proportion of fixed carbon or unconsumed combustible in the ash drawn from the backs is very small, and much less than the leading authorities agree is permissible for the proper maintenance of CO_2.

Vicars' stokers are made to operate with all forms of accelerated draught—induced or forced obtained by means of fans, steam jets, etc.—but the latter form is generally adopted. The ends of the bars and front of the furnace are boxed in and vertical or horizontal blowers attached to the bottom of the casing which is about level with the bottom of the furnace. A pressure equal to 1 inch or more can be easily maintained under the bars and round the air passages in front of the furnaces. Very low-grade bituminous fuels can be used, either caking or non-caking. The same machine can be made to give the very best results when working under all conditions, and the change from natural draught to forced draught or *vice versa* can be made instantly.

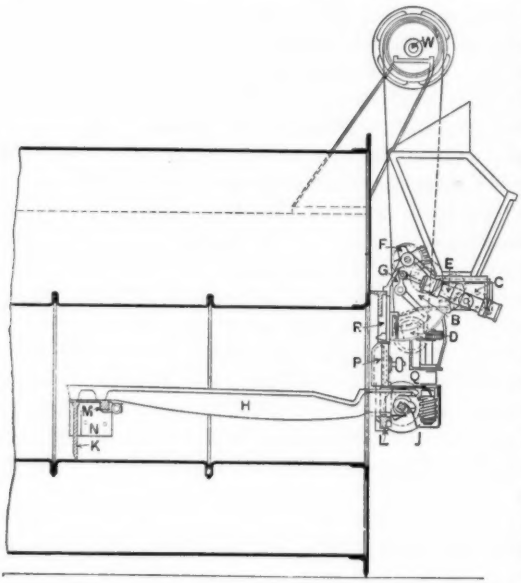
James Hodgkinson's coking stoker is another of the coking type.

This stoker has a minimum number of working parts, none of which come into actual contact with the fire. It consists essentially of a suitable receptacle for holding the fuel, the base of which is a hollow ram or pusher having forward and backward motions, actuated by means of sectors and racks fixed within. The sectors are keyed to a shaft which is rocked only by means of a crank disc and lever arranged to give a variable movement to the ram at will. The ram on its forward movement allows the fuel to fall into the space formerly occupied by it, and on its return pushes it over a top plate so constructed as to spread the fuel onto the bottom coking plate, always keeping the sides well filled. Immediately above the ram is a steam jet of special shape which induces a current of air through the incandescent mass of coke which is always at the front. The back of the stoker front casting is well protected by means of cast-iron blocks filled in with non-conducting material, and allowing of an air space between them and the front, so keeping the whole cool. Immediately under the ram is the fire door which is of the usual hand-firing size, although

during work it is never opened as the action of the firebars efficiently carries the fire to the back end and deposits the clinker and ashes into the chamber at the end of the firebars, from which they are removed underneath the bars. The bars are worked by triple cams, so arranged that each alternate bar is drawn forward, the remaining bars being meanwhile held back until such time as the leading bars are at their full travel; then they are released and drawn forward to a common level. All the bars retire together. This action ensures that the air spaces are always open, particularly when a fresh supply of fuel is added, and the cams are further arranged so as to give a short dwell at this point in order that the fuel may be properly ignited before being disturbed. The overhead shaft makes about 200 revolutions per minute, which is reduced by means of worm gearing running in oil so that the ram shaft makes about 1½ movements per minute. Beyond filling the hoppers and removing the ashes the machine needs little or no attention. At one of the mills of the Fine Cotton Spinners' Association a Lancashire Boiler 8 feet 6 inches diameter, with two flues, fitted



FRONT SECTIONAL ELEVATION OF THE "TRIUMPH" STOKER.
Ransomes & Rapier, Chiswick, London.



SIDE SECTIONAL ELEVATION OF RANSOMES & RAPIER'S TRIUMPH STOKER.

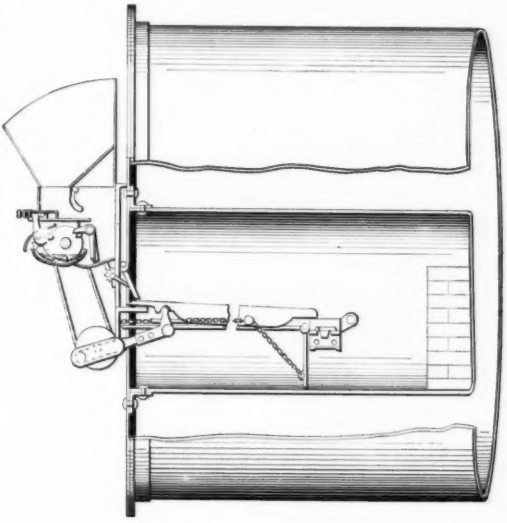
with these stokers and bars, consumed 17½ cwts. of coal per hour for months together during alterations, without causing visible smoke — a result impossible with hand firing. On a four-day test this stoker showed 33 per cent. economy in expense and 21.6 per cent. increase in boiler duty over hand firing. In another trial with the latest type of Hodgkinson stoker, the gain over hand firing was 11.66 per cent. in economy and 30 per cent. in boiler duty. Using Newcastle small slack under a Hornsby water-tube boiler, the boiler efficiency secured was 63.35 per cent., and the evaporation of water from and at 212° per pound of coal was 10.43 pounds. Tests with the Hodgkinson stoker on a Hornsby boiler in competition with hand firing showed a gain for the mechanical stoking of 0.3 pound water per pound of coal.

The McDougall and the Auld stokers are generally similar to Vicars, and a test of the former by Mr. R. B. Longridge showed a gain in evaporation over hand firing of 8 to 12 per cent. The Cass stoker, which has a flat grate, is spoken of as being very efficient. The Falmorden stoker, by Haworth and Horsfall, has a coking chamber built of firebrick between the hopper and the boiler front; the fuel is agitated by toothed rakes which rise between the grates and cut the fuel, moving it about two inches at a time. Meldrum's "Koker" stoker has been used at a rate of combustion as high as 40 pounds per square foot of grate per hour, giving 11.9 per cent CO_2 and 7.4 per cent. O in the escaping gases.

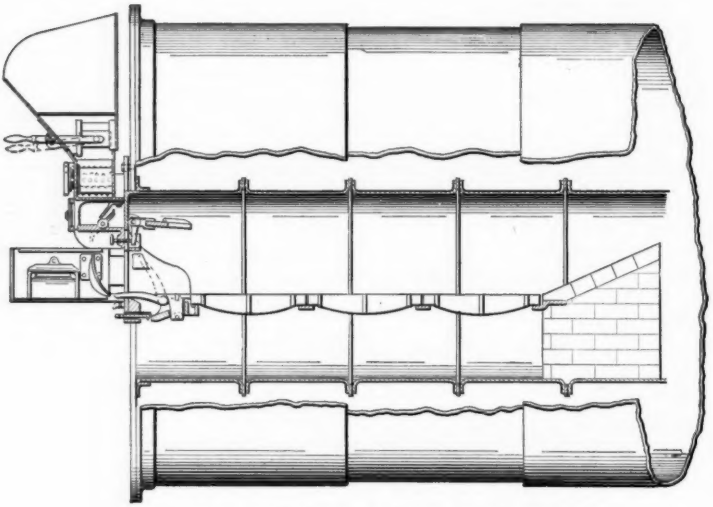
e. Sprinkler stokers:—

In the Triumph stoker, made by Ransomes & Rapier, the coal descends from the hoppers into a box containing an adjustable slide having a reciprocating movement. At regular intervals this allows coal to fall on a shovel, which by a cam, trigger, and spring is driven sharply forward but with a varying throw, so that the coal is uniformly distributed over the grate. The firebars have a come and go motion of about 2 inches, being drawn forward by two and two in succession, and then after a slight pause, all pushed back together. By this means the clinkers and ashes are caused to travel backward until they finally fall from the extremity of the bars into the ashpit. A series of small steam jets helps to keep the bars cool and to increase the draught. In a twelve-hour test, burning South Hetton unscreened coal (bean small) in a Galloway boiler with 47 square feet of grate surface and 1,140 square feet of heating surface, the fuel burned per hour was 1,150 pounds, or 24½ pounds per hour per square foot of grate, giving an actual evaporation of 8.45 pounds of water per pound of coal, equivalent to 8.9 pounds from and at 212 degrees. The feed water was at 204.1 degrees, steam pressure 122.3 pounds, average draught at induced fan 0.81 inches of water. The gases left the boiler at 868 degrees, and the economizer at 348 degrees. The fuel left 8.9 per cent. of ashes.

Other forms of sprinkler stokers are Henderson's, in which the coal is broken up as it comes from the hopper, falling onto fans which spread it over the bars. This, together with Deacon's improvements, is now controlled by the Mechanical Stoker Company. Proctor's stoker spreads a thin layer of fuel over



PROCTOR'S SHOVEL STOKER.



WHITTAKER'S MECHANICAL STOKER. SPRINKLER TYPE.
William Whittaker, Yorkshire St. Ironworks, Burnley, Lancs.

the fire by the quick sharp movement of a vane or shovel of sheet iron, the motion being produced by a cam. In the E. S. E. mechanical stoker the same action is obtained by three blades set at equal angles, the spreading being effected by a special fan-like deflecting disc. The quantity of coal fed can be regulated at the feeding boxes, the sprinkler shaft being turned at uniform speed.

Wm. Whittaker of Burnley, builds a sprinkler stoker having revolving shovels and spreading plate which cover the fire bars equally all over. The annual cost of repairs is given as 1 per cent. of the cost of the stoker, and the only gearing used is one gear and one worm wheel, and two ratchet wheels and two engaging dogs. The fire bars are stationary. The Leach stoker is a form of sprinkler stoker much used in Germany and on the Continent, and has shown under a Lancashire two-flue boiler a boiler efficiency of 66.3 per cent. The Frisbie is an American type of sprinkler stoker in which the fuel is fed on a circular grate.

My next article will discuss the general economy of mechanical stoking, with many illustrations of important installations at home and abroad.

FEATURES OF EUROPEAN LOCOMOTIVE CONSTRUCTION.

By Charles R. King.

II.—THE LOCOMOTIVES OF ITALY AND AUSTRO-HUNGARY.

Mr. King's first article, which appeared in the June issue, reviewed the structural and mechanical peculiarities and the running qualities of the French compounds. A concluding article will present a brief study of the latest locomotives of Switzerland, Saxony, Russia, and Northern Europe.—THE EDITORS.

INCREASING volume of modern locomotive boilers interferes with the easy sighting of signals by the engineman, and for this reason on the largest American engines built for the French State Railway and in the latest Bavarian-built engines on the French Eastern Railway, the engineman's place has been transferred to the left-hand side of the cab. The new compound engines of the Southern or Adriatic lines of Italy are also disposed in this way.

Express Compound Engine, Southern Railway of Italy. This novel type of locomotive, the peculiarities of which are illustrated by the engravings, has—besides the recognised advantages for outlook possessed by tank-engines specially designed to run either end foremost—many features interesting for the future construction of locomotives. The engine, constructed at the company's shops at Firenze to the designs of Signor Plancher, was first exhibited at Paris in 1900 and a number were subsequently built by Borsig of Tegel near Berlin and Breda of Milan and put into regular service in May, 1902.

Its appearance in 1900 drew out many criticisms and notes of interrogation, but since that time the design has been followed to some extent in recent French tank locomotives and has been indicated, by competent men, as a solution to the question of how to obtain a large effective heating surface with fireboxes and boilers of moderate length, as opposed to the customary plan of extending the whole generator forwards to a great length and coincidentally removing the cylinders from the source of the heat and lively steam, a plan by which a serious loss of power is inevitable unless some form of superheater is provided to recover part of the lost thermal efficiency. The placing of all the driving and coupling axles beneath the boiler very conveniently leaves the low space beneath the firebox for a four-wheeled truck just where, in the four-connected type of engine, a simple radial axle is now

FOUR-CYLINDER COMPOUND EXPRESS ENGINE, SOUTHERN RAILWAYS OF ITALY (STRADE FERRATE MERIDIONALI, RETE ADRIATICA)

The whole of the engine is painted enamel black and highly polished; chimney, dome, and boiler bands are also polished black; there is no picking out whatever. The engine runs cab first.

very generally added. By thus turning the boiler around on its frames an extra pair of wheels has been avoided.

The cylinders have accompanied the boiler in this reversal, although there is reason to believe that in the locomotive of the future they may be returned to their original position over the pivoting truck. The firebox stands above the four-wheel truck, and in that position the footplate is necessarily situated above the free-swinging end of the locomotive where the lurches ordinarily felt upon striking a curve are hardly perceptible except by a sinuous lateral movement of the foot plate. The pivotal oscillations or side-lash common to long engines with a short rigid wheel-base and radial displacements at either end of the frames are here reduced to about half—as I have had opportunities of noticing in the riding of American "Atlantic" type engines and the Italian locomotive over the very same section of the French Western Railway—the reason being that the latter locomotive is rigid at one extremity—the smoke-box end.

This locomotive has no "idler" wheel behind the drivers and the truck at the front end allows possibilities for an immense development of the firebox, far beyond that attainable with any single axle below the furnace. With a very short grate the area in this engine is, nevertheless, superior to that of the *Nord* "Atlantic" type.

The outlook from the cab in front of the boiler is of course the very best that could be devised for a locomotive, and altogether preferable to the half-way arrangement adopted many years ago by the Reading road. The entire width and length of the track up to within a few feet of the cab are visible to either the engineman or fireman from any position on the footplate.

The disposition of the high- and low-pressure groups of cylinders is also novel. As in the Vauclain compound, there are but two piston valves, 7½ inches and 7⅛ inches respectively, for the high-pressure and low-pressure pair of cylinders; but that pair, with the Italian engine, consists of high- and low-pressure twins, the distribution realised for the two equal-sized cylinders being more perfect than if the valves served two odd fellows. The steam passages from each valve are crossed so that each opposite end of the twinned cylinders is always in connection—ensuring thus uniformity of pressure in the two cylinders and compensating for the irregularities of distribution due to the varying angles which the connecting rods form with their respective cranks. Unlike the ordinary Vauclain, the Continental practice is followed in the placing of two of the cylinders inside the frames, with these differences; that, in place of two low-pressure cylinders, there is but one

high-pressure and one low-pressure located inside; and instead of the connecting rods having only two driving pins (as in the ante-1902 Vauclain) they have four—that is, each outside crank stands at an angle of 180 degrees with its nearest fellow inside, and the two sets stand at 90 degrees with each other. Here again the Italian differs from the usual Continental practice in having all the main rods working on the same pair of driving wheels (the middle pair) instead of equally dividing the work as usual between two pairs of the connected wheels; the result, however, is the same as regards obtaining an equalised twisting moment with diminished strains and wear as compared with a two-cylinder or ordinary Vauclain compound. The appearance of two small cylinders on one side of the engine's axis and two big ones on the other would, at first sight, suggest some want of balance, but as far as could be judged by the movements of the machine at all rates of speed the whole engine appears to be most perfectly balanced longitudinally, vertically, and transversely.

As they are arranged the cylinders, in spite of their crossed passages, have the very low proportion of clearance volumes of 10 per cent. for the high-pressure and 7½ per cent. for the low-pressure, but from actual experiments made with the Exhibition locomotive it was decided to increase these volumes by tentatively augmenting the piston clearances, in order to enable the engines to steam yet more freely and economically at high speeds.

The Italian locomotive was designed for an effective rather than an apparent simplicity—two very different matters. It has only one reversing screw, placed along with the throttle handle in the front end of the cab, and the admission of live steam to the low-pressure cylinders when starting the engine is always automatic and due to the opening of the throttle. This regulator is a double-slide relieved valve of bronze, which when slightly opened uncovers a central hole in the dry-pipe seating so that steam escapes away to the low-pressure valve chest, and when opened still farther this small aperture becomes thenceforth closed and is not reopened in the return of the valve across the live-steam inlet, and this by reason of the preliminary closing up of the supplementary valve with the first half-inch of return travel.

The special manner of introducing the live steam to the low-pressure valve-chest by passing it first into the casing of the high-pressure valve spindle extension, has some resemblance to the Gölsdorf starting system as far as concerns its valve-seating inlet for live steam. With the Italian engine, however, a groove combined with a "flat" on a false

valve extension-spindle permits the auxiliary steam supply to enter the high-pressure exhaust whenever the high-pressure valve is in such position that starting must take place by the low-pressure cylinders and to this it arrives by passing from one chest to the other via the horse-shoe bend in the smokebox. On this bent pipe are placed (just back of the chimney) a relief valve and an air suction valve; the steam pipe in the smoke box is also fitted with an air valve. Each set of piston valves is worked from the middle driving wheels by an eccentric crank and the Walschaert form of valve-gear now universally adopted on the European continent.

The Exhibition engine had a very low-placed blast orifice variable by an internal pear-shaped plug, and only regulatable by a screw from beneath the smoke box.

The outside cylinders are horizontal and those inside the frames are inclined 8 degrees from the horizontal in order to clear the rear coupled axle. The main guide bars are single with a truss bar below, the flat bronze slide of the piston cross-head being guided in the narrow interval between the two. The middle webs, only, of the crank axle are inclined 95 degrees from the center line of the axle, and the outside webs stand, as usual, at right angles. The crank axle and journals are 7½ inches in diameter. The main driving rods inside have forked ends closed by fixed blocks and the brass is set up by a screw wedge. The outside main rods and coupling rods are of solid or box pattern. A peculiarity exists in the method of attaching the fire box to the plate frames by means of four broad feet, forged solid with the foundation ring at its front and back lower edges, these feet riding in special brackets and engaging in large buckles secured to the frame sides to prevent any chance of lifting.

The truck cradle differs from the usual arrangement in having the laterally swinging frame so broad that the lower centres of the pendulum links are spread apart equal to about the width of the road gauge, while the fixed centres on the truck frame above are set yet wider apart. The truck frame is of course of a special pattern, with outside sills of I section and with outside journal boxes. To prevent a too free transverse oscillation of the cradle frame, the pivot bearing is made of very large diameter according to the latest American practice for steadying this movement. The direct lateral swing allowed is 2 inches. A fore-and-aft oblique vertical movement of the truck is also possible under the same restriction, the two ends of the cradle-frame casting being rounded underneath where they rest on the bellied longitudinal tie bolts of the hanging links.

The boiler is of a type which has come into favour recently on progressive lines in east-central Europe, with the American form of spreading firebox standing above the frames and a slightly coned ring at the firebox end of the barrel. The inner firebox crown is flat with long-radius corners. Its stays are not radial, but the outer crown sheet is very strongly stayed with heavy channel girders connected together with a double row of transverse ties.

In conclusion it may be mentioned that the engines are very finely painted in a brilliant black, without any relief lines of any sort, and present externally a remarkably fine appearance.

Ten-Wheeled Express Locomotive, Mediterranean Railway of Italy. This six-connected two-cylinder compound locomotive was constructed by Gio. Ansaldo & Co. at Sampierdarena to the plans of C. Frescot and G. Bartoldo (former and present superintendents of mechanical power of the *Strade Ferrate Mediterraneo*) and named the "Alessandro Volta." It is the first of an entirely new type in Class 4, to be numbered 3151-3200.

As a cross-compound it represents many up-to-date features, although preserving the general external characteristics which have distinguished the locomotives of this line of railway for a number of years past, and of which a specimen—an eight-wheeler, the "Giovanna d'Arco"—was exhibited at Paris in 1889.

This compound engine, of which the boiler pressure is 174.5 pounds, has one piston valve with external admission for the high-pressure cylinder and a balanced slide valve, with its more reliable steam-tight qualities, for the low-pressure. Both valves are of bronze. The low-pressure channeled valve is relieved by two projecting circular plates 11 inches in diameter. The back covers of both large and small cylinders have the same diameter. The low-pressure back cover is fitted outside, and the high-pressure back cover fitted inside the cylinder, and all four covers have 1¾-inch relief valves. A combined air inlet and relief valve is also provided on the receiver. The spring for the receiver steam-pressure is set at 94 pounds. No receiver gauge is provided.

An automatic Von Borries intercepting valve is located transversely to the locomotive at the foot of the 8¼-inch horse-shoe receiver pipe above the low-pressure valve chest. This is a disk valve of bronze, 7½ inches in diameter, which, when the engine has to be started on the low-pressure side, closes the way between the two cylinders under the pressure of live steam taken by a 1¼-inch pipe from the elbow pipe in the smokebox. This steam enters a large bore in the

valve-spindle guide at a place where the spindle is so turned down in its diameter as to form a shoulder, or piston, against which the steam acts in forcing it inwards, so closing the large valve mentioned, and at the same time uncovering four holes in the spindle-guide through which the same steam enters into the passage just above the low-pressure valve chest; but, as the pressure is slight from the small surface presented by the shoulder, the whole is driven outward again upon the first exhaust from the high-pressure cylinder, thus covering up the leak holes into the low-pressure and opening the receiver to the exhaust steam, which then works compound. An automatic attachment has been designed by Signor Giordana by which, whenever the engine is reversed and run against steam, a jet of water under pressure is thrown up the blast to prevent the aspiration into the valves and cylinders of gases and cinders from the smoke box. This is arranged by an extension on the spindle just mentioned, carrying a 6½-inch cylindrical valve which can be forced outwards by the action of steam and water, admitted from the boiler by a special cock, and which, when it has forced the valve into a position corresponding to the intercepting-valve being set for working compound, escapes by a hole in the bottom of the cylinder into a ⅝-inch pipe leading down to the exhaust pipe of the low-pressure cylinder and thence to the blast.

A very suggestive feature is to be remarked in the front end of the framing—the side frames are contracted to only 2 feet 10⅝ inches between plates, and are of Siemens-Martin steel 1⅛ inches thick. In this way, even with the large cylinders employed (21¼ inches and 31½ inches diameter) the distance between piston centers is reduced to 6 feet 4 inches and so the main rods are brought in against the pin seats, while the side rods, contrary to custom, are placed outside. This reduces the bending stresses on the pin and diminishes the leverage on the axles, the result tending to promote as much steadiness as it is possible to attain in outside-cylinder engines. The second half of the side rods is of course brought inside against the pin seats for the second and third pair of drivers. The truck has inside frames with outside axle boxes. Its wheel base is 8 feet 2½ inches. The frame carrying the pivot is swung upon 11¼-inch vertical links. This pivot is of a novel kind, being in the form of a hollow sphere 12⅝ inches in diameter and bolted underneath the transverse main-frame casting previously mentioned. It is carried in a cup bearing of bronze, the rectangular external sides of which are fitted within a steel-casting box, and this in its turn is supported underneath by two transverse rods coupling the ends of the truck swing-links and

guided transversely between the vertical girder plates of the truck. There being no side rests for the main frames the truck has in consequence a universal movement, and to permit of this the domed collar which covers up the top sides of the pivot, bearing etc., is allowed a certain clearance and, as this space might admit dust, a flexible hermetic joint has been made by inserting a ring of 1¼-inch rubber piping into opposite grooves turned in the collar and in the flange of the pivot. Combined with the universal movement there is an arrangement for controlling the side swing by means of a short tension-rod pinned by one its ends to a lug at the bottom of each side of the pivot box and passing thence through coiled springs contained in muffs outside the frames, to a cap at the other end of the rod which compresses the spring in against the frame whenever the lateral effort exceeds 1 1/5 ton.

The Exhibition locomotive was constructed of the finest quality materials and with the greatest care, the specifications containing very rigorous clauses as to the particular nature of the metals employed and concerning their testing and final working up. All the principal screws are cut to English standards. The finish of the whole locomotive exhibited was of the highest order; it was painted a dark green relieved by brass bands and beadings. Signori Giordana and Cuttica de Caffine both collaborated in the designing of this new type of locomotive. In service it runs the fast passenger traffic between Rome, Pisa, and Genoa, where the grades vary from 1 in 100 to 1 in 83. It is capable of taking loads of 220 tons net at 56 miles per hour under favourable circumstances. If the speed is not high, that is due more to local requirements and regulations than to the capabilities of the locomotive.

Hungarian State Railroad Compound Express Engine. The two-cylinder compound locomotive exhibited by the Magyar Királyi Allamvasutak is the first of a new type which includes also some simple-expansion engines.

It is of the ten-wheel four-connected type, which with its uncovered wheels and extended smoke-arch is suggestive of American origin. Although presenting a great departure from previous models of the same railway, yet it is not susceptible to the reproach of being an innovation, and therefore a "gimcrack-freak," for it is made up in detail from constructional features which, though they may be novel to us, have for the greater part all passed that trial stage indispensable to a legitimate incorporation with the time-honoured mould patterns that have so far served to cast Stephenson's locomotive.

The Exhibition locomotive, No. 701 of Class (Osztaly) II. was de-

signed by the state railway engineers Paul Roth and Hubert Dvorak for the heavy express-train service on the Marchegg-Budapest line. The grades are of about 0.7 per cent., the loads 220 tons, and the coal employed, from the Austrian mines of Dambrau and Karwin, is equal to that generally employed on Austrian railways, producing six pounds of steam per pound of coal. The speed required is not high, but in this, as is general in Central Europe, it is not the want of engine power which is responsible. The coaches forming the trains worked by these locomotives are of great size, hardly smaller than those of Russia, and equipped with an attention to comfort that is not excelled elsewhere. The engine is started with a half-automatic valve somewhat resembling in its parts the Von Borries valve. It is placed longitudinally above the low-pressure valve chest and controlled from the foot plate by a lever operating two parallel rods. The upper rod works the valve at the foot of the 2-inch live-steam pipe, which takes its supply from the elbow pipe in the smoke box. The lower one passes through a larger hollow rod working in a stuffing box, and to its end is screwed a 6½-inch disk valve serving to close up, whenever required, an auxiliary exhaust pipe from the high-pressure cylinder to the chimney. The outside or hollow rod mentioned is not worked by hand. At its end is an 8¾-inch disk valve which closes up, independently of the smaller disk, that part of the receiver passage leading from one cylinder to the other.

In action the apparatus works thus:—On starting the engine the direct exhaust for the small cylinders is opened by pulling the fulcrum lever backwards. The live-steam valve on the upper spindle being opened at the same instant, the boiler steam flows into a conical annular chamber, back of the stuffing box, and thence passes by four holes into an internal bore in which a shoulder, turned upon the hollow rod, forms a sort of piston which is driven backwards until the 8¾-inch valve closes the way to the high-pressure cylinder while, at the same moment, a number of grooves milled in the circumference of the small piston are thrust into the receiver allowing the live steam to escape past it through the receiver into the horse-shoe pipe and around to the low-pressure valve chest.

Whenever the engineman considers the speed sufficient he pushes the lever forward, closing thus the direct high-pressure exhaust and shutting the small live-steam valve. The exhaust steam from the high-pressure now acts automatically in driving forward from its seating the large valve, which until then had barred the way to the low-pressure cylinders.

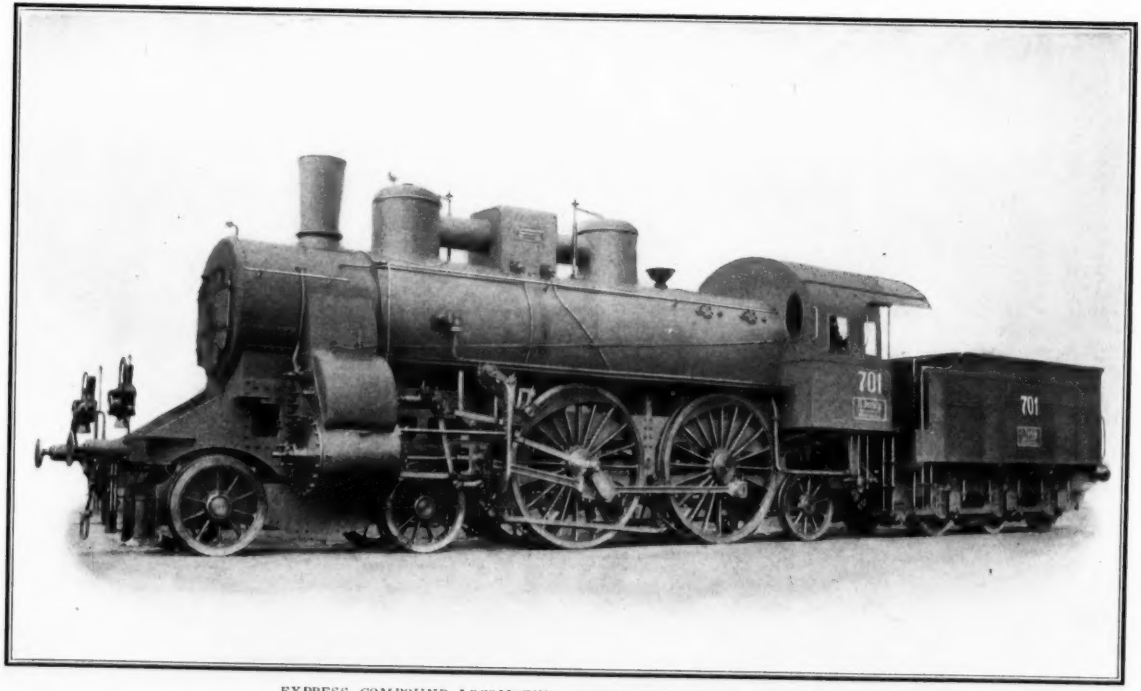
Unlike some live-steam valves or cocks, taking their supply direct from the boiler, in this case the auxiliary steam is to some extent regulated in proportion to the pressure of that in the high-pressure cylinder, since it is controlled by the amount of the opening given to the throttle. And, moreover, if at any moment in starting the throttle should be suddenly shut, that action cuts off the live steam independently of the starting valve. The relief valve on the receiver is set for 95 pounds; the normal pressure therein is about half that quantity. The boiler pressure is 175 pounds.

The cylinders are 19⅜ inches and 29½ inches diameter with piston stroke of 26¾ inches. The driving-wheels are 82⅜ inches diameter and the maximum tractive effort is 10,912 pounds.

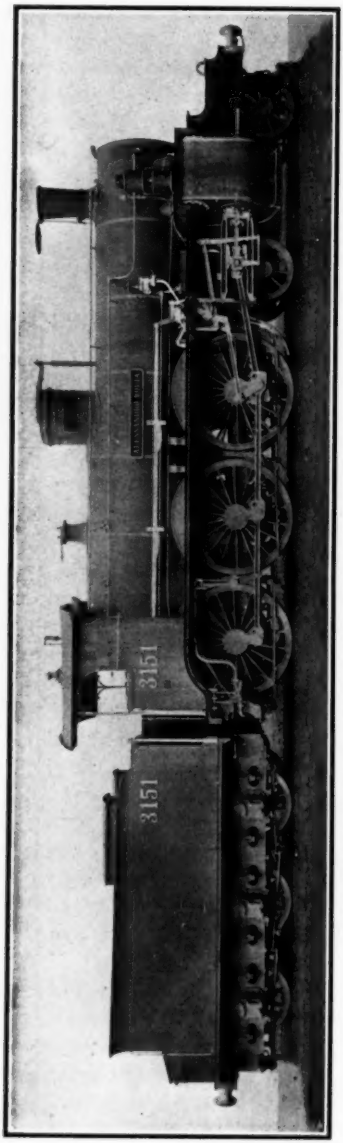
The valves are of the half-balanced type, steam channelled, and backed with Von Borries' relief plates, and the valve seatings are inclined at about 45 degrees. The valve gear is Heusinger's. The main driving-rod big ends are of great size in proportion to their rods, and present a remarkable contrast with American rods. The brasses are strapped in and held up with double gibs and a simple cotter. The side rods have solid or box ends, with their cotters fixed as usual by a stud screw.

The frames of the engine present a number of peculiarities. First and most striking is the built-up plate saddle beneath the smoke box, from which the side frames descend to below the cylinders in a line unbroken by the running boards, which usually conceal these front ends. The side frames are of steel 1 3/16 inches thick, and their edges along the oblique line from the smoke box to the side buffers are polished. A steel caisson extends from the smoke-box front to the motion brackets—a length of 9 feet 7 inches—which is stayed transversely by a horizontal plate of steel castings. Vertical flanged plates descend from the smoke box down to the base of the pivot trough, a distance of 4 feet 3 inches. The whole construction is such as to present a very rigid fixing for the cylinders. Further back the side frames are braced by vertical plates supporting the boiler under the first and third rings, and finally by the drag-beams under the foot plate.

The truck under the front end has universal movement without a hanging cradle. The truck frame is made up of cast-steel plates 1 inch thick and has a length of 11 feet 10 inches and a width of 3 feet 4½ inches; the frames are placed inside the wheels and the journal boxes outside the frames. At the front end the deep transverse plate forms a rail guard or pilot, and besides the transverse plate behind



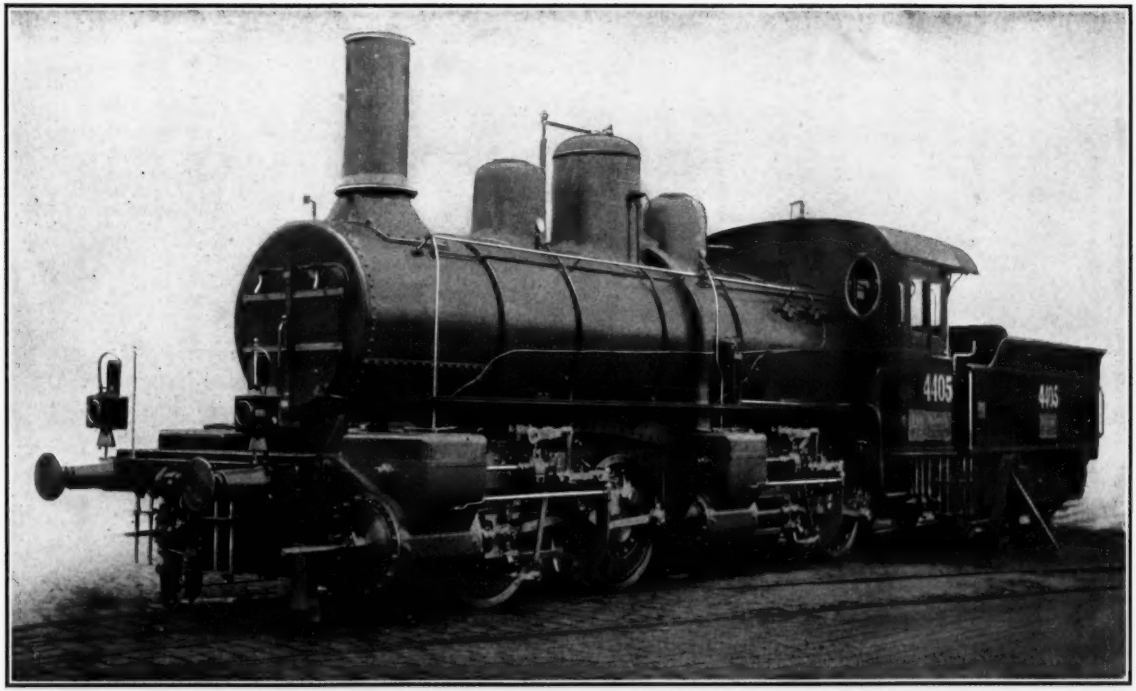
EXPRESS COMPOUND LOCOMOTIVE, HUNGARIAN STATE RAILWAYS.



COMPOUND LOCOMOTIVE ALESSANDRO VOLTA, MEDITERRANEAN RAILWAY OF ITALY.
Is fitted with combined Von Borries-Giordana valve.

there are four tie rods bracing together the opposite axle-box guides. In the middle two vertical-plate girders support a fixed transverse steel casting or bed, having a cup seating for the pivot 17½ inches diameter, displaced 2 inches behind the middle of the truck. The pivot itself is a high rectangular casting with a spherical bearing, and its sides are planed to fit exactly and slide between the main-frame traverse or trough already mentioned. Consequently on curves the engine frame is permitted a direct lateral play, of 1 13/16 inches on each side of the pivot. The energy of this movement is reduced by plate springs set longitudinally at each side of the frames, and acting in antagonism by their free ends being coupled together by transverse rods and their camber pins butting against the opposite sides of the sliding pivot.

The pivot is held to its seating by a large-headed bolt passed from the inside of the casting, through a conical hole in the sphere and into a tight-fitting long socket in the seating below, to which it is secured by a wedge key. This step bearing is run with white metal. Vertical swivelling of the truck is controlled by two



HUNGARIAN COMPOUND FREIGHT ENGINE WITH NO EXPANSION LINK.

The fixed link of the ordinary Walschaert gear is replaced by a combination of radial arms which fulfils the same function.

springs under the frames at their outside edges. Such flexible side supports for the main frames must, at the same time, not interfere with direct lateral displacements nor tilt on their seatings through any momentary vertical divergence of the truck. All this has been effected by the use of spherical side rests, cast beneath lateral projections on the pivot casting. These round feet rest in cup bearings; the flat seatings of the latter are free to slide about on the recessed circular heads of two plungers below, which in turn are supported upon fine volute springs contained within cylindrical cavities cast on each side of the truck bed.

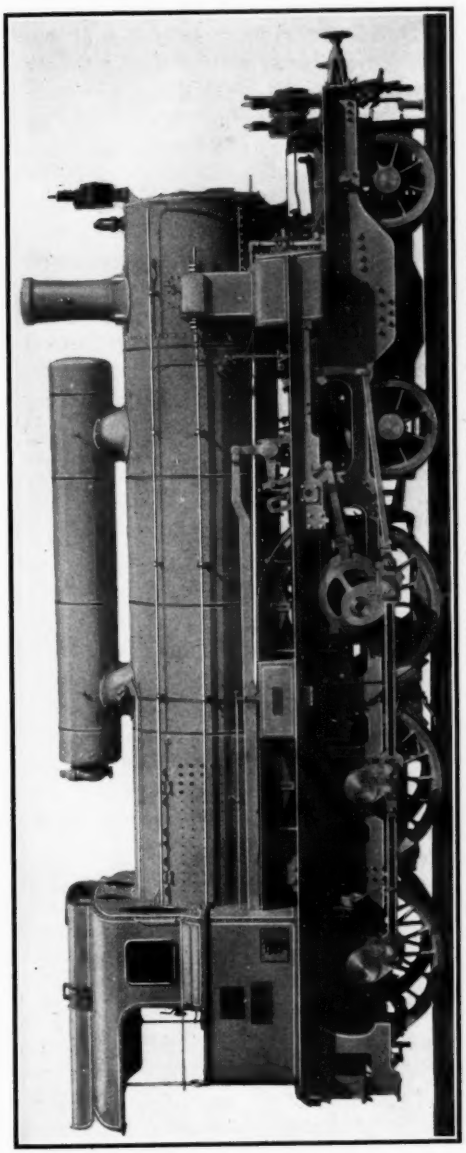
At the opposite end of the engine frame an equally uncommon device is employed for allowing the engine to swing radially around the quadractic pivot represented by the four points of rail contact below the driving wheels.

First of all the journals here have a direct lateral play of 5/16 inch on each side of their boxes, and these boxes are pivoted vertically so as to rotate partially around a shallow stud 3⅛ inches in diameter turned upon their crowns. The vertical ends of the boxes, to permit this rotation, are shaped to a radius of 4⅝ inches upon a width of 4 inches. They are accurately fitted into a special shoe or fork of cast steel, answering to the ordinary axle box with its flanges, which in this case are made very deep so as to allow a play longitudinally of ⅝ inch for the back and front guides of the horn blocks.

On curves the axle keeps square with the rails, but is drawn askew with the frames—without, however, those strains usually set up in all the parts concerned nor the wear and tear and necessarily increased frictional resistance.

Two-Cylinder Compound Engines, Austrian State Railways. Each of the Austrian locomotives exhibited at Paris presents certain peculiarities of construction differing from those of countries lying more to the west, and all have but two cylinders, arranged in such manner (on the Gölsdorf system) that no intercepting valve in the receiver is necessary. There are, instead, two small live-steam inlets in the low-pressure valve seatings, so located at each end of the valve travel that it is only when the engine is starting or is otherwise demanding much power from the boiler, with the reversing screw in full forward gear, that one of these apertures is uncovered; the counter opening for running backwards is then closed by a rib cast in the slide valve. The arrangement is sufficiently interesting to bear describing again for those who may have forgotten its action.

This system has found an extensive employment in Austria and



TWO-CYLINDER TEN-WHEELED COMPOUND LOCOMOTIVE, AUSTRIAN STATE RAILWAYS.

Peculiar in the dispositiorf of the eccentrics and of the rod to drive the advance lever; and (for Austrian practice) in having inside cylinders, which are so large that the frames have to be spread on the outside of the wheels. Gölsdorf valve gear.

Russia, since, joined to its great simplicity, it avoids the expenses for maintenance and repairs incidental to special starting valves. It has, moreover, rendered a two-cylinder compound engine equal to, or, with the valve gear as employed, even superior in starting powers to a single-expansion engine; while the crippling effect of an automatic valve, cutting off the live steam after the first exhaust, is here entirely suppressed.

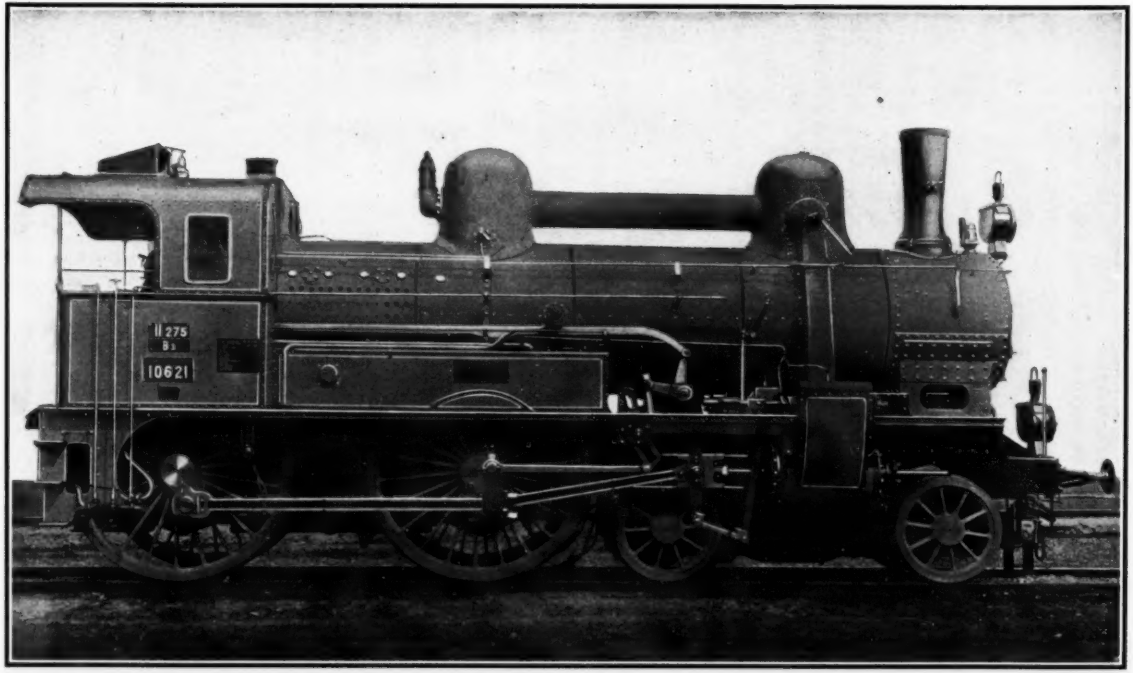
The six-connected two-cylinder engine is not only remarkable in its general external aspect, but, as will be seen by comparison of the principal dimensions of this and other engines, it is notable also

for its power, particularly for a two-cylinder engine. It has a larger grate area than any European express locomotive of which mention will be made in this review, and its theoretical tractive effort at point of rail-contact is, with its two cylinders, but little less than that of the Nord four-cylinder 4/10-connected express locomotives. Its height is about 4 inches less than that of the imposing, but less powerful, two-cylinder engine of the Hungarian State Railways. The Austrian engine has also the longest stroke of any of the engines mentioned. A long stroke means greater starting power, for if carried to an extreme it means(always given the requisite adhesion) the tractive effort of a freight engine in starting and, later on at high speeds, a degree of expansive working with a very early cut-off which would render compounding unnecessary.

It means also a very high average piston velocity, but this, according to American experience, is not prejudicial; so that, pursuing this comparison—long versus short stroke—*ad absurdum,* it is simply surprising that such an elastic form of power as is available in the first should be so little utilised with all its unsurpassable range of adaptation on the scale of adjustment between power and speed, comparable to the crank-pin being gradually slid inwards from the periphery to the axle center as to the requirements for power diminish from the maximum of adhesion to nil.

The boiler, it will be at once remarked, is increased very considerable in its capacity as a hot-water reservoir by the addition of a longitudinal cylinder in place of domes, distantly resembling the Nord superheating locomotives of M. Petiet, exhibited in England in 1862, and also the more recent and still highly satisfactory Flaman locomotives of the Est. The form of the cast-iron chimney is seriously detrimental to the æsthetic apearance of all these *Oesterreichen Staatsbahnen* locomotives.

The location between the frames of such a large casting as that, having cylinders 20⅞-inches and 31⅞-inches with their valve chests, presented some difficulty. To accomplish this the inside-cylinders engine of Mr. Worsdell had the axes of the cylinders in a different plane; some German and Swiss locomotives have the frames bent outwards, and M. de Glehn, without bending the frames, built engines with two inside 23¾-inch cylinders by allowing a part of the inside cylinders to protrude through an opening slotted in the side plates. In the Austrian locomotive M. Gölsdorf obtained all the room desirable by the very unusual Continental practice of placing the frames well to the outside of the wheels, similar, it may be remarked, to the designs for com-



LATEST TYPE OF TWO-CYLINDER FOUR-CONNECTED EXPRESS ENGINE WORKING THE PARIS VIENNA TRAINS, AUSTRIAN STATE RAILWAYS. GÖLSDORF VALVE GEAR.

pound-engine arrangements submitted by Mr. A. Mallet to the Institution of Mechanical Engineers, London, 1879. This arrangement called for a longitudinal frame plate in the middle as a central bearing for the cranked axle, which is moreover of a very strong design.

The cylinders are inclined from the horizontal in order to clear the front truck axles of the cross-head guide bars. A distinct peculiarity of arrangement, necessitated by the various changes, is in the Heusinger valve gear, the advance lever of which had to be driven from some other point than the usual one on the cross head. The motion is therefore derived from the end of the coupling rod; and in place of the usual eccentric cranks for driving the links, a very large eccentric was substituted. The valves are placed vertical and their chests project outside the frames. The main steam pipe is brought through the smoke box just above the high-pressure valve chest and the throttle valve is very simply fitted thereto.

The front truck, with an immense wheel base but in proportion to the driving-wheel base, supports a swing frame or cradle, the oscillations of which are controlled by a traversing rod and short central coiled spring. The play limit on each side is 1½ inches. A hollow step bearing in the cradle supports a small half-sphere pivot, but vertical motion, or rolling, is prevented by side supports under the cylinder casting and resting upon angle brackets projecting from the truck-frame sides. The rear coupled axle has a play of ¾ inch on each side. The main frames are so wide that they project over and partly conceal the truck wheels.

The cabs of these railways have an upper clerestorey ventilator so as to keep the cab clear from the emanations of the lignitic coal whenever the throttle is closed. The cab is ten feet wide. The air inlet valve is combined with the receiver relief valve and mounted above the horseshoe pipe in front of the smoke box. The engine illustrated was constructed by the Maschinenfabrik der Oesterreichen Staatseisenbahnen Gesellschaft (late John Haswell) of Vienna. It is not intended for the fast speeds common in Western Europe, but it can haul loads of 450 tons up grades of 1 per cent. and eight miles in length at a steady speed of 26 miles per hour. It indicates 1,300 horse power in its regular work on the Amstellen-Pontelba division, whereon the curves descend to 720 feet and 625 feet in radius.

Four-connected Compound Engine, Austrian State Railways. The two-cylinder compound here illustrated is employed in one of the fastest Austrian service of International trains. It is of a new class, No. 106, resembling very much the precedent class "Series 6" but of

greater neatness in external appearance. Its distinguishing features are the great wheel-base of the front truck—8 feet 10 inches as compared to the driver wheel-base—9 feet 2 inches—and to the total wheel-base—23 feet 10¾ inches. In the motion are to be remarked the very long and straight advance levers of the Heusinger gear—curved in the Series 6—and the hollow driving- and side-rod pins. It will be noticed that all the rods are channelled and, proportionately, very light. The main-rod big end is forked; the side-rod has the rear end of box pattern and the front end forked—instead of the reverse as customary. The manner of fixing the bearings for the expansion link-pivots to a short longitudinal frame below the running board is a practice peculiar to the *Oesterreichen Staatsbahnen.*

In these new engines the lever safety valves on the dome connecting pipe have been replaced by Coale valves behind the dome; some previously existing boiler fittings and discharge pipes have here been covered in by a large casing pipe projecting through the top of the cab, and the sloping ventilator on the cab roof has been made much higher than in the previous class.

The throttle valve in the forward dome is cylindrical and operated by an outside rod, and the steam pipe is carried direct from the dome to the high-pressure valve chest under a jacketing. The small mounting in front of the chimney contains a double-seated valve—one valve for relief of the receiver, the other with a light spring unseating readily for the inlet of air. The front truck pin is fitted with a round-edged collar bearing to prevent strains.

In actual service these locomotives haul trains of 265 tons net load upon rising grades of 1 per cent. at from 25 to 28 miles per hour, or up grades of ½ per cent. at from 40 to 44 miles per hour. With a light load of 155 tons on the level they have made 65½ miles per hour, and with experimental trains of two coaches they have run at 81 miles per hour. It has to be remembered that the coal used is very poor.

These Austrian locomotives are painted in black with red fine lines.

The principal dimensions are:—Boiler pressure, 191 pounds; cylinders, 19⅝ inches and 30 inches by 26¾ inches stroke; drivers, diameter, 84¼ inches; tractive effort, 14,960 pounds; heating surfaces:—fire box, 123.7 square feet; tubes, 1,554.8 square feet; total, 1,678.5 square feet; weight, empty 55 tons; loaded, 61.25 tons: under driving wheels, for adhesion, 31.5 tons.

MONEY-MAKING MANAGEMENT FOR WORK-SHOP AND FACTORY.

By Charles U. Carpenter.

VI.—THE MACHINING AND TOOL EQUIPMENT.

Mr. Carpenter's articles began in THE ENGINEERING MAGAZINE for February, 1902, the first and second papers dealing with factory organization in its general principles and concrete examples, the third with departmentalization and systematization of the works, and the fourth and fifth with the stock department and its systems. His next paper will deal with the very important subject of piece work. Mr. Falconer's article on pages 573-582 is an interesting supplement to Mr. Carpenter's discussion.—THE EDITORS.

T seems almost superfluous to state that a manufacturer should give most careful consideration to the best effective means of manufacturing his product accurately and cheaply. I believe, however, that it will prove profitable to approach this important subject on the most rational and scientific basis that we can. If any question deserves the attention of every manufacturer or superintendent, it is: "What are the secrets of cheap and accurate production, and how can I apply them to my own business?"

In considering the question of production we should keep in mind the processes and means that should be adopted to attain those results which mean so much to a business—*cheap, accurate and quick production.* To secure this, every device of modern organization, machinery, and system must be called to our aid. The organization should be so devised as to bring out the best efforts of the foremen and workmen and provide the closest supervision over the work. The machinery and tools should be selected with a view to meeting the special peculiarities of the product. The systems should be such as to give perfect checks on both the men and the product, and to supply data for a system of reports which are comprehensive and give the closest insight into the conditions of all departments. The product must be manufactured in large quantities; its parts must be standardized; accuracy of parts must be insured; fitting must be reduced to as low a point as practicable so as to insure quick and cheap assembling.

These requirements may be grouped into three classes under the general heads of Organization, Machinery, and Systems.

Organization of the Machine Room.—Careful and close study is not often given to the organization of the forces of the machine rooms

in such a manner as to produce the best results. Too often is it the case that foremen and assistants are secured, placed in charge of a department, and then left largely to their own resources. The results are a number of departments developed according to the comparatively limited ideas and experiences, and, possibly, broad prejudices, of a number of men. Each man will develop his department along the lines of his "old shop" and will hang on to those ideas and their consequent development "like one possessed." After each one has put his pet ideas and theories into practice it is very difficult to get new ideas introduced. If, however, a general plan of organization, a well-digested policy of handling men, and a thoroughly comprehensive series of systems are introduced, it is comparatively easy to get the new comer to "fall into line" and assist in these new ideas.

Arrangement of Machining Departments.—Wherever possible, machines should be grouped together according to the class of work which is performed upon them. This is usually not possible in cases where large work is turned out. In such a case, the machines should be so placed as to insure, so far as possible, the steady progression of parts through the shop from one end to the other until the parts are finished. In cases where the machines themselves are brought to the work, the problem is simplified. However, where the parts are many and comparatively small, the different machines should be grouped as stated. One or more groups can be placed in charge of one foreman.

The principles of organization described in the earlier articles can, with profit, be adapted to the machine rooms. It was shown in those articles how the head of the factory has as his advisory board the different factory supervisors; how each supervisor has authority over, and is held responsible for, results from a certain number of departments selected for him according to his particular ability. Each foreman of a certain group of machines, or department, then looks to the supervisor of his group for orders and advice.

At the very beginning of the discussion of departmental management, consideration must be given to the question of securing the full efficiency of the high-priced foremen. It is certain that one of the most important links in the chain is the foreman. As he is, so will his department be; as the departments are, so will be the quality and the cost of the product; and on the quality, quantity, and cost of the product hangs the success of the business. I contend that one of the greatest mistakes of many, if not most, firms, is the loading up of the foreman with detail work that cheaper men can do as well as he. A firm employs a foreman and pays him a high price because of his sup-

posed knowledge, experience, and ability. His chief aim should be to improve the quality, lower the cost, and investigate improved methods, machinery, and systems. To accomplish this and also to carry the load of detail work usually pushed on him, is impossible.

Study the conditions of each department and never hesitate to appoint one or more assistants if the conditions justify it. Any other course is false economy in the highest degree. The number of men that a foreman should have supervision over will vary according to the character of the work. It is safe to say, however, that no group of over twenty men should be left without supervision. I do not mean to say that an assistant foreman should be appointed for each group. Instead of this, I suggest the selection of one of the best workmen as "job boss"; let him continue his work at the bench, paying him a small sum per day more than the remainder of the men. Enough authority can be given to each job boss to enable him to secure the results desired. Each assistant foreman should have certain jobs and job bosses under him, and all should be accountable to the foreman.

Meetings.—Meetings of foremen, assistants, and job bosses should be held weekly. There can be taken up for intelligent discussion the troubles and defects of the product. Men can make suggestions that will better their product, or they can tell what is hindering them from securing certain results. Give them proper encouragement, and the results will be surprising. Ways will be found out of difficulties, valuable suggestions will be made, surprising economies will be effected, and personal interest in the work will be aroused. The effect on the rank and file of the workmen will soon be in evidence. Each workman will see advance only a few steps ahead of him in a job-foremanship, and many of them will make up their minds to aim for it. Each job boss will realize that his next step will be to an assistant foremanship, should he prove capable. The assistants feel that they have an opportunity to show their worth, and a healthy rivalry will soon spring up and creep down to the bench bosses and to the men. With such a system of organization, it will be possible for the foreman to unload upon his assistants a great deal of the detail work that is hindering him from giving to the firm the real and greatest benefit of his brains, experience, and ability. His assistants will soon find that they can safely trust their bench bosses with a part of their details. These men will take pride in their responsibility and will give the closest attention to the carrying out of their orders. Working at the bench they have a knowledge of the smallest details of the work, which, when made use of, is very valuable.

Reports.—It is important that a very comprehensive system of reports, showing details of output, hours worked, payroll, costs, amount of piece work and day work, be devised for each department. It is a most satisfactory and necessary thing for the superintendent and will be found invaluable for purposes of comparison. It is only by means of such reports that the superintendent can be kept in close touch with the factory work. This is usually as much neglected as it is important. In a large establishment it is a very easy matter for large losses to occur, especially when the non-productive payroll is a goodly percentage of the total. A system of reports will show this before any large losses are made.

Machinery.—I am a strong believer in the policy of scrapping old machinery when new and improved machinery appears upon the market. Of course, consideration must be given to the interest on the cost of the old and new machines and the amount gained in economy by the increased output. But if, as is often the case, the advantage is decidedly on the side of the new machine, it is, to say the least, short-sighted to hang on to the old slow machines. But I hear you say: "Let us keep the old machines until we can better afford it." What will you do when your competitor seizes the opportunity, installs new machines, and you find that you are unable to compete with him? You will then not be equipped to meet him. No, force your tools; wear them out quickly. Your depreciation will be high, but your product will be cheaper, your profits larger, and the old machines the sooner make way for new machines that will give an increased output at the same expense for power and labor.

Careful study should be made of the recent great improvements in the quality of tool steel and the processes of hardening. These subjects bear a most important relation to that of "large output." "High cutting speed" means a material lowering of costs, and is a subject that will well repay investigation. In fact, in some shops keeping all machines up to the highest possible point of efficiency, this is deemed so important that a special "speed foreman" is appointed. It is his duty to see that all tools are running so that the greatest output possible is being attained. This is certainly a good idea.

It is conceded that one of the chief reasons for America's commercial success is her automatic and multiple machinery. These marvels of speed, accuracy, and output (the American automatic screw machines) are in many cases kept below their capacity by lack of knowledge of what can be done with them. There is required a man of the highest type of mechanical knowledge and ingenuity at the head

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of an automatic-machine department, in order to get the best results from the machines. In up-to-date departments, work that was formerly declared impossible is now being done. This work is remarkable not only in amount, but also in accuracy. Certainly no set of machines gives so large a return on the investment as do these.

The "magazine attachment" now makes possible in the case of partially completed parts the same economy gained by producing parts automatically from the solid raw material. The parts loaded in the magazines are automatically delivered to a special fixture, which holds the parts firmly while the machining is being done. This is a decided step in advance of the hand machine and will result in large economies.

It is of interest to note the advance in the quality of work produced on automatic machines. Parts requiring the greatest accuracy can be manufactured in very large quantities and at a very great reduction in cost. Work is being done on automatic machines to-day that a few years ago was regarded as absolutely impossible. It is very difficult to convey any definite idea of this work without elaborate illustrations. Pieces of all sizes and complicated forms are produced from the solid stock. I have in mind many pieces that are produced, the working points of which must shut out light when they are put on the gauges. These pieces are produced by the thousands daily with a percentage of loss from defects so small as to be inappreciable. Many of these parts have over ten machining operations on them. The relation of these points one to the other must be almost absolute. Such pieces are now produced on the automatic machines at about one-fifteenth of the cost of the hand machines.

The same advantages are obtained by much of the multiple machinery now on the market—for example, a new type of automatic multiple drill press operated by a boy, from which can be procured four times as much work as can be gotten from the ordinary drill press with an expert operator working it. Horizontal and vertical holes can be drilled at the same time with this press, three jigs can be used, and the drilling is well-nigh continuous. The work done is of the highest quality. Such machines will pay for themselves within a few months in decreased cost of product. I believe that the field for automatic, multiple, and special machinery is only beginning to open up.

The special-machine designer certainly has a place in our shop organization of to-day. Such a man, of original and inventive mind, can make a study of the special needs of any product and can design special machinery that will produce parts cheaper by far than is done with the ordinary machinery and processes. The duties of this po-

sition would differ from those of the designer or inventor of new machines or products for the market. The importance of having an entirely distinct department for inventions of new product and improvement of the old, will be considered later.

Special Tools and Gauges.—The modern up-to-date manufacturer needs no argument to convince him of the great advantages of having a generous tool and gauge equipment. However, many firms, not so progressive, have not yet been convinced that the returns from such an investment would justify the expense. The outlay is very apparent—the returns problematical, in their opinion. Modern practice tends more and more in the direction of a large equipment of this character. With proper tools and gauges, the output per man will be much larger and more accurate; the chance of error will be reduced to a minimum; duplication of parts becomes possible; a lower grade of workman can be used on work requiring even the greatest accuracy.

I wish to reiterate a statement made in a former article, viz.:—tools and gauges should be frequently inspected. As will be shown later, this should be the duty of the man who has charge of the models. By using a "Daily Reminder Card Index" the work can be systematized and so simplified. When a foreman secures a tool from the tool supply room he should have some assurance that that tool is in good condition and that accurate work can be produced by its use. It often occurs that the jig or fixture becomes worn little by little, and this is discovered only after a large amount of stock has been manufactured.

Tool-Designing Room.—As the accuracy and cost of the product depends very largely upon the character of the tools used, so does this latter depend upon the tool designer and the organization of the department. Good tool designers are as scarce as they are important. They must be men who are of an inventive turn of mind, practical, and open to receive suggestions and absorb new ideas. Many men in this line of work are both ingenious and practical, but fall far short of their full efficiency because of their mental attitude toward suggestions from others. The tool-designing department is the one of all others for discussion and suggestions. There should be the fullest and freest expression of thought and interchange of ideas between the members of the department and the foremen who use the tools. Ordinarily, this is far from being the case. There is usually a distinct line between the designer of the tools and the men who have acquired the knowledge of their defects and good points in everyday work. I have seen cases where expensive sets of tools were designed and made, even though a set built upon similar lines had proved anything but

successful. If the designer had availed himself of the foreman's ideas and knowledge which was gained from experience, large sums of money could and would have been saved. The fact must be constantly borne in mind that, in the handling of small work, particularly, more time is required to put the parts into the jig or fixture and remove them than is consumed in doing the actual work itself. This "jig time" is a most important factor and should never be lost sight of or neglected. It is necessary also that the condition of the machinery, its style and capacity, should be borne in mind when any new tools are designed. A tool designer should make himself thoroughly familiar with all the shop conditions, as well as the peculiarities of the particular parts for which the tools are intended, before designing these tools. He should be thoroughly informed as to what styles of tools have proved successful and what have not.

To avoid mistakes and get the benefit of the experience of others is a simple matter of organization. In the first place, regular meetings of the corps of designers should be held. Here should be discussed the best methods of designing tools, mistakes commonly made, and improvements upon the work in general. Criticisms and suggestions on the work in hand should be gotten from the entire body of designers. Ideas will be brought forward by such methods that will prove most valuable. The foremen of the tool room and some of the machine rooms should be present, especially when the question of new tools is being discussed. In such meetings the foremen should make reports showing the value of various classes of tools in everyday work. Their opinions and advice will be found to be of the greatest value. Every draughtsman should make a personal study of the tools finished according to his drawings; everything should be done to educate the draughtsmen and secure the advantage of the suggestions and criticisms of everyone, and especially of those who use the tools. In many modern shops there exists a system of inspection of drawings. These are carefully examined by the supervisors. Tools cannot be built without their approval.

I do not intend to give or suggest any ideas concerning the details of a system for a tool designing department. Such points have been clearly brought out in other articles in this magazine. My aim has been to present briefly a fundamental, though simple, idea of organization which has proved of great value many times in my experience.

Tool-Supply Department.—One man, or one department, should be held responsible for all tools and models. As suggested, this man should inspect all tools and gauges at regular intervals, to insure their

accuracy. All tools when not in use should be in his custody; when they are being used they should be charged to the workmen using them. The proper time to inspect a tool is when it is handed in by a workman. If it is out of order the responsibility for its condition can be placed upon the proper party immediately. The workmen, after they have learned this fact, will use great care in handling the tools. Naturally, this man who has charge of the tools, should be a mechanic of the highest type. He will soon learn thoroughly not only the tools, but also the parts for which they were designed. He can then be appointed a "general-trouble man." A very important part of his duties can properly be the ferreting out of the causes of trouble in the producing of parts. In large establishments where parts must be manufactured with great accuracy, such a man will have a great deal of work to do. By the nature of his work he will be better fitted than anyone else to find out the cause or causes of such difficulties and to correct them. This man would be a most valuable member of the committee suggested for the consideration of tools and their design.

The Tool Room.—The tool-room costs are a constant thorn in the side of most manufacturers. It is hard for them to realize how important is a well-equipped tool room, unless they are men who have had practical experience in a machine room. The fate of many concerns rests finally upon the tool room and the character of its work. First-class tools result in first-class work and cheap production: defective tools result in endlesss expense, worry, and finally, bad reputation because of defective parts.

Thorough and effective organization is certainly needed in the tool room. The conditions there are different in many respects from those in other departments. Piece work is not possible. The work itself requires the greatest care, and should not be unduly hurried. The methods adopted for increasing the output must be carefully considered. By considering again the "secrets of cheap production" we can get some clues that will prove most valuable. We can then learn what methods to avoid and what to adopt. The work should be so divided as to leave only that requiring the greatest accuracy to the high-priced man. Each workman should have his own particular job assigned to him, and on that he should concentrate his attention. Parts should be standardized and manufactured in large quantities on automatic machinery wherever possible. In place of piece work, some system should be adopted that will spur the men on to do their best. The men should feel that opportunities for advancement exist should they prove themselves worthy. The plan outlined differs radically

from the system in force in many shops to-day. This old-style plan where the high-priced tool maker builds up the tool in all its details, is not practiced in many modern shops. Such a system is directly contrary to modern ideas. In this proposed plan the tool maker is but a high-priced assembler and adjuster. Most of the parts that go to make a jig or fixture are made by cheaper men, who, working constantly at one style of work, can produce it much faster and at a greatly reduced cost. This plan should be worked out to its fullest extent. Nothing but the very finest and closest work should be done by the tool makers. The sizes for parts of jigs and fixtures should be standardized as fast as possible. The component parts of these tools should be manufactured in large quantities and carried in stock. The great economy gained by manufacturing such pieces in large lots will much more than make up any loss of material occurring from the fact that the tool may be slightly larger in some dimensions than necessary.

Other parts also, such as legs, screws, bushings, etc., should be manufactured in large quantities. Much of this can be done on the automatic machines. These can also be carried in stock ready for immediate use. Everything possible should be done to prevent any delays to the tool makers. The line should be sharply drawn between the different jobs. These jobs should have over them a job boss—a man selected with great care. Each job boss should understand that he has the opportunity to make a record for himself in accuracy and cheapness of production. Knowing that his record will be examined, his desire to call attention to his work will lead him to take great interest in getting out a large output at a low cost. Thorough inspection of tools and tool cost records can be made with great profit. This inspection of tool cost records is very important. A card for each tool containing the detailed costs should be sent to the supervisor. These details should include costs of material, designing and building the tool; the time and cost of labor in the tool room should be itemized operation by operation, together with the names of each workman. Each tool and its card should be examined by the supervisors and heads of the tool and tool-designing departments. If the tool is considered too costly, this fact and the reasons for it should be noted at the bottom of the card. After the foreman has called the attention of the tool maker once or twice to adverse comment on the quality or quantity of his work, and the workman realizes that this is making a perpetual record against him, the improvement will be astonishing.

The tool room is a good training ground for foremen and assistants. Promotions from this department should be made whenever

possible. I have seen instances where the product of the tool room had increased over 50 per cent. with very little increase in cost under such a plan of organization as is briefly outlined. No detail of system should be neglected which will relieve, or tend to relieve, the high-priced tool makers of work that can be done as well by a lower-priced man. The method of supervision of work should be complete and thorough. The men should understand that individual records will be closely watched and that the sluggard is apt to be discovered and discharged and the earnest worker recognized and rewarded.

Assembling Rooms.—The same plan of organization should be followed out in the assembling rooms. The work should be divided into separate jobs, each important job having its job boss. The closest supervision should be kept of work and men. Unless the assembling-room organization is thorough, there will exist chances for large losses. The system of inspection can be extended with great profit in these rooms. As in the machine rooms, each man's time ticket should contain the name of the inspector certifying to its correctness before the man can get his pay. Each machine assembled should be properly numbered, these numbers entered upon a book, and opposite these machine numbers, the names, or check numbers, of every man who has worked upon it. Thus in case the machine develops defects in use the man responsible can be easily located. As stated a number of times in this article, nothing should be left undone to eliminate filing and fitting in the assembling rooms. The workmen should be taught (it will require teaching) that the parts should come to them in perfect condition and that, if wrong, they should be sent back to the original inspectors, who should properly be held responsible for defective parts.

Whatever piece-work system is adopted, it should provide a complete check on all day work and piece work. In a large assembling department the amount of money spent on day work when piece work should have been done will be astonishing. This is especially so when work becomes slack. Careful detailed records of output, payroll costs, etc., should be kept.

Inventions and Improvements.—Progress can be made only through inventions and improvements. A firm must exercise great enterprise in the line of inventions to hold its own in the market. The day is gone when a concern can secure and hold business simply on its reputation gained in the earlier days of its existence. Enterprise is too keen, its spirit too progressive, to hold to the old because of its age. A business concern and its product can not stand still. If it does not progress its competitors surely will. The old maxim "A stern chase

is a long chase" applies nowhere better than in business. Once your competitor has improved his product, built his tools, covered the improvements with patents, and secured the prestige on the market which comes from having a superior and improved article, your difficulties multiply and your sales decrease. Invention is the order of the day. Recognizing this fact, my plan includes the organization of an Inventions Department whose sole business would be the invention of new products for the market, and the study and improvement of old products. The consideration of the needs of the market should receive attention of all the members of the organization, especially the selling force. The selling force come into close touch with the prospective customers and are thus in a better position to judge of the needs of the market than any others. The consideration of suggestions for inventions should receive the attention of the ablest men in the organization. There should be formed a special committee for this purpose. The inventions department should work according to orders from this committee.

Testing of Inventions.—Many firms can, from their unfortunate experiences, testify to the need that inventions shall receive thorough testing before tools are made and the product placed upon the market. The tendency almost invariably is to rush the new product onto the market much earlier than is advisable. An invention should be thoroughly tested and considered by a large number of men before it is finally accepted. It is always advisable to have made a tool model and testing model. The testing model should be turned over to the factory force as soon as completed. From that time on the authority of the inventions department, as far as concerns that model, should cease. These testing models should be thoroughly inspected and tested by all the experts and inspectors in the establishment who are fit to pass judgment upon the machine. Reports of these tests should be made in writing by each man. These reports should cover any defects found, or any suggestion in the line of improvement. The results will be surprising. Defects will be discovered and improvements suggested that were never dreamed of by the inventor. The testing model together with the reports should be turned back to the inventor. Such methods will insure a perfect and complete product. In no other manner can a firm guard against the dangers of placing untried and imperfect machinery upon the market.

Let a firm possess a well-formed organization backed up by good inventions, tools, machinery equipment and systems, and there can be but one result—Progress.

THE FACTORY OFFICE AS A PRODUCTIVE DEPARTMENT.

By Kenneth Falconer.

IV.—ITS RELATION TO THE GENERAL MANAGEMENT.

With this article Mr. Falconer concludes a series which began in THE ENGINEERING MAGAZINE for April last, and which has described a system of "Money-Saving Organization for the Office" supplementing Mr. Carpenter's current series on "Money-Making Management for the Workshop."

Mr. Falconer's first paper presented the general theory of his view; his second discussed specifically the relations of the factory office to the stores department and shops; the third took up the relations to the stock room and shipping department. In this he displays its immediate and special value to the executive.—THE EDITORS.

UCH of the value of factory accounting is in many cases lost by regarding it strictly as cost accounting, which in reality is only one of its branches, and the effects of a really efficient system are ofter neutralized by failure to present the results obtained in such manner to be of greatest value. This may readily be caused by a misconception of the true uses of a system of order numbers—that is, of a system whereby all expenditures, whether of labor, cash, or material, and all receipts, transfers, and deliveries of any articles or goods, are made and recorded on the authority of a written numbered order, the number of which must in every case appear on the records of such expenditure, receipt, transfer, or delivery. The real value of such a system will be apparent only when it is regarded as a means of first obtaining such individual records in as minute detail as may be desired; then of grouping the individual results in such detailed divisions and sub-divisions as may be most expedient; and finally of presenting the totals of each such group in a manner not only to afford complete and accurate records of the past, but also to be of the greatest value as guides for the future.

To secure the best results along these lines, the factory office must be supplied with an official list of the ledger accounts, each account with which the factory is in any way concerned being divided into sub-account and detail as may best suit existing conditions; no new account affecting the factory in any way must ever be opened without

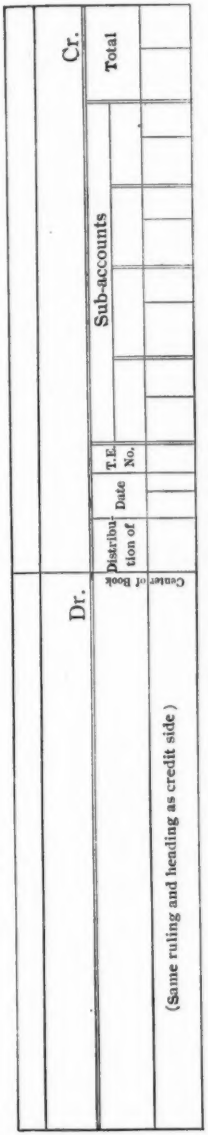
ascertaining if the items to be charged to it do not properly belong to one of the already existing accounts, of which they should show as a part. In such case a new sub-account will retain the individuality of the items and result in more accurate and scientific accounting. Assuming the case of a manufacturing company with three productive

ACCOUNT	SUB-ACCOUNT	DETAIL
Shop Expense	Shop A	Superintendence
		Defective Work
		Miscellaneous
	" B	ditto
	" C	ditto
Repairs to Plant and Equipment	Shop A	*Fixed Machines
		Shafting Belts and Pulleys
		Tools
		Miscellaneous
	" B	ditto
	" C	ditto
Factory General Expense		Heat and Power
		Fixed Charges
		Superintendence
		Miscellaneous

NOTE A. PARTIAL LIST OF ACCOUNTS, SHOWING SUBDIVISION OF OPERATING AND MAINTENANCE EXPENSES.

departments, the accounts should be listed and divided somewhat on the lines shown in Note A, the example given being for the operating and maintenance accounts only; but all should be divided on somewhat similar lines. The illustration is purposely not carried out to great detail, but an examination of it will show how elastic it is and how capable of being adapted to suit the requirements of any produc-

* By the use of a special ledger with an account for each machine, this is further subdivided and each machine shows its own expense of maintenance, depreciation written off, and value in plant account.



FORM I. HEADINGS AND RULING FOR PAGE OF SUB-LEDGER.

tive concern. If each order and the sheet or book page to which the charges against such order are entered, shows the name of the account, sub-account, and detail to which these orders are chargeable, it is a simple matter to group the charges each month under their correct headings and ascertain the totals. In the list of accounts given, the general ledger will show the gross charges against the accounts; the sub-ledger (see Form I) shows the same amounts, but distributed amongst the various shops, and the monthly transfer entries (Form II) will show further details. All charges against the orders are taken off each month, and must balance with the records of material issued and wages expended. When the transfer entries are complete a summary showing the total debits and credits to each account, sub-account, and detail is taken off on the same form. From this summary, or from each transfer entry, as preferred, the amounts in the column headed "Accounts" are posted to the general ledger and the transfer entries returned to the factory office. The amounts in the columns headed "Sub-Account," and also the total under Account are then entered in the sub-ledger, and the summary of the transfer entries is in itself the record of the monthly total of the details. For purposes of comparison these totals may be entered on a form ruled in parallel columns for a certain number of months. Form III for this purpose is ruled for a quarterly report, and a similar form to which the total of these quarterly statements is transferred is used for the final report covering the year. The value of such reports should not, however, be sacrificed to uniformity, and the information transcribed from the summary of the transfer entries need not be entered in

Name of Account	of Sub acct.	of Detail	DEBIT							CREDIT							
			Amount of Detail		Sub. Led. page	Amount of Sub. Acct.		Gen. Led. page	Amount of Account			Amount of Detail		Sub. Led. page	Amount of Sub. Acct.		Gen. Led. page	Amount of Account	
Wages	Shop A														1000				
	Shop B														1000				
	Shop C														1000				
	Misc.														500			3500	00
Shop Expenses	Shop A	Suptce.	90	00															
		Dif. Wk.	90	00															
		Misc.	90	00		270	00												
	Shop B	ditto				270	00												
	Shop C	ditto				270	00		810	00									
Repairs to P & E	Shop A	Fixed Machs.	100	00															
		Shftg. B & P	100	00															
		Tools	100	00															
		Misc.	100	00		400	00												
	Shop B	ditto				400	00		800	00									
Carried forward									1610	00								3500	00

FORM II. MONTHLY TRANSFER ENTRY, SHOWING PART OF DISTRIBUTION OF WAGES.

Operating and Maintenance
Accounts for Quarter Ending

	Jan'y	Feb'y	Mach.	Total
Shop Expenses				
Shop A				
B				
C				
Total				
Repairs to Plant and Equipment				
Shop A				
B				
C				
Total				
Factory General Expenses				
Heat & P.				
Fixed Chgs.				
Suptce.				
Misc.				
Total				
Summary				
Shop Exp.				
Repairs to P. E.				
Fac. Gen. Exp.				
Total				

FORM III. SPECIMEN SHEET OF QUARTERLY REPORT.

Annual reports containing totals of the quarterly are compiled on similar forms.

the sequence in which it there appears, but may be so grouped that all results regarding a certain shop or department may be found together, if so desired. For instance, the amount of non-productive labor in a certain shop, or of fuel consumed in the foundry, shown in conjunction with the total labor in that shop and with the weight of castings pro-

duced during a given period, will convey more meaning if the same figures appear merely as details of labor, of fuel account, and of output. Arranged thus, they may readily lead to economies the necessity for which might not have been otherwise recognized. A series of four such quarterly reports, with a summary showing the totals of each, will form a most comprehensive record of the outcome and totals of the year's work.

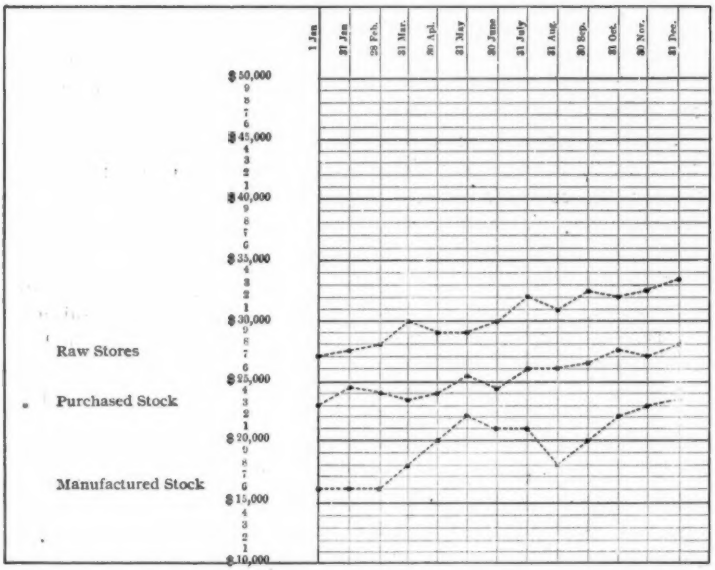
The recording and indexing of individual costs of goods manufactured or work done has been treated in a previous article. It is an open question as to how much such individual costs should bear of the extra work caused by defective material or workmanship, or by breakages during manufacture, and how much of such expenditure should show as a manufacturing or shop expense. If circumstances justify it, a close watch can be kept on this matter by having all regular manufacturing orders bear even numbers. When a defect is discovered, or an accident happens necessitating extra work or material, the factory office is applied to for a "defective order," and an order is issued bearing the odd number immediately following the even number being worked upon. This order is credited with the scrap or actual value of the defective part. A new part to replace it is charged up, and all time consumed in putting such part into the same condition as that which was found defective is booked against the odd number. On completion of the original order the extra expenditure is either added to it or allowed to remain in "Defective Work Account." In either case the management have always the exact costs, both with and without the extra charges caused by defective workmanship or material, or by accident or breakage. In addition they have a record of the total expenditure arising from such causes, and should be able to judge whether it is reasonable or abnormal.

Much of the existing prejudice felt by the managements of industrial concerns against a proper system of factory accounting arises from a feeling that the information and results to be obtained therefrom will have served their purpose when they have been carefully studied and examined, and will be thereafter of no further use. For this, accountants themselves are largely to blame. Such information and results should be so presented that their value may be best utilized as a guide to similar operations, or future transactions under similar circumstances. This may frequently be done by employing diagrams showing proportions and percentages, which will sometimes point out leaks more plainly or indicate undue increase in expense more vividly than figures representing gross amounts.

The advisability of using curves and diagrams, and the respective advantages of showing gross amounts or percentages thereby, is not merely a matter of individual preference. These questions should be decided only after examination as to what purposes the results under consideration are intended to serve, in what light they may be of the greatest value, and in connection with what other information they will carry most meaning. For instance, if the figures to be recorded represent a fact complete in itself, and whose only value lies in itself and in comparison with similar records of previous periods, then figures in parallel columns will serve every purpose. If, however, in addition to comparison with previous results it is desirable to know whether the tendency from month to month is towards increase or towards decrease, diagrams representing gross figures should be used. The value of basing curves or diagrams on proportions and percentages is evident when the meaning and value of the information to be recorded depends largely upon its relation to other items—items possibly of a different nature, but to some extent at least dependent on and affected by it. In other words, parallel columns of figures show results and afford opportunity for comparison; in the same direction curves based on gross amounts are of equal value, but in addition to making the differences more noticeable they force attention to the general tendency of the results. Curves representing percentages and proportions, if properly planned and carefully executed, afford equal opportunity for comparison, are equally insistent in forcing attention to differences and to the general tendency of the results, and to a greater extent than might be thought, will indicate the relation between cause and effect. It is well to remember that whether the ultimate result is good or bad, it is equally desirable that the causes producing such result should be known, that they may be developed and encouraged, or guarded against, as they make for, or against, success.

Of these three different ways of recording information, such items as the actual value of the plant in each shop would serve every purpose if simply recorded by figures in parallel columns as on Form III. On Form IV will be found examples of information shown by curves based on gross amounts, which convey more meaning than if figures in parallel columns were used. A glance at this diagram will show very plainly that any profits made are rapidly being locked up in stores and material—good, doubtful, or bad, as events may prove.

Examples of curves based on percentages will be seen on Forms V and VI. Looking at the profit on sales of goods made in Shop A, it will be seen that they are rapidly reaching the vanishing point and



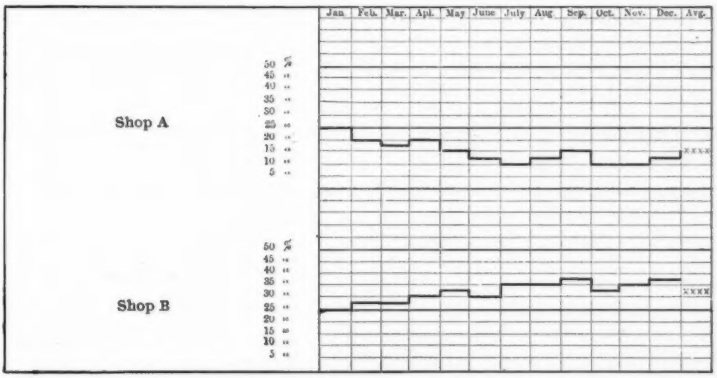
FORM IV. CURVES BASED ON GROSS AMOUNTS, SHOWING RAW STORES, PURCHASED STOCK, AND MANUFACTURED STOCK ON HAND DURING THE YEAR.

average for the year about 15 per cent. The profits on the manufacture of Shop B show a steady increase and average for the year almost 32 per cent. Assuming that both these shops produce standard articles sold at regular prices, a reference to the proportions of productive and non-productive labor in each shop, as shown on Form VI, will throw light on the cause of this condition of affairs. The non-productive labor in Shop A shows a steady increase, and an average for the twelve months of about 37½ per cent., while that in Shop B has only once gone above 25 per cent. and for the remainder of the year runs about normal, averaging a trifle over 22 per cent.

In no department of a manufacturing business can diagrams be used to more advantage than in the foundry, where so much depends upon the quantity or weight of the output. Let the total production be represented by 100, and by means of curves show in proportion the number of hours worked and the average cost in material, in moulders' wages, in floor labor, and in shop expense; the weight of fuel consumed, the loss in melting, the weight of bad castings produced, and the many other items which in a foundry may vary so greatly, accord-

ing to the attention paid to small matters. The result at the end of a few months may point out possible economies or evident leaks that otherwise might not have been noticed. It is of course understood that the figures used in these illustrations are altogether suppositious, and are used more in view of a desire to show the information that can be brought out than in view of any probability of the proportions ever occurring. The improbability of the results, however, lies only in their degree, not in their nature.

It is a truism to say that these are the days of specialists. In the most advanced technical and trade papers the general tone of the advertisements is the statement that the advertiser can do some one thing or make some one article better than anyone else. In this question of technical accounting is a field for specialism, the importance of which is only now being recognized. I have tried to show that the department responsible for this work has a wider field than is generally thought, how it may be made a strong factor for efficiency in



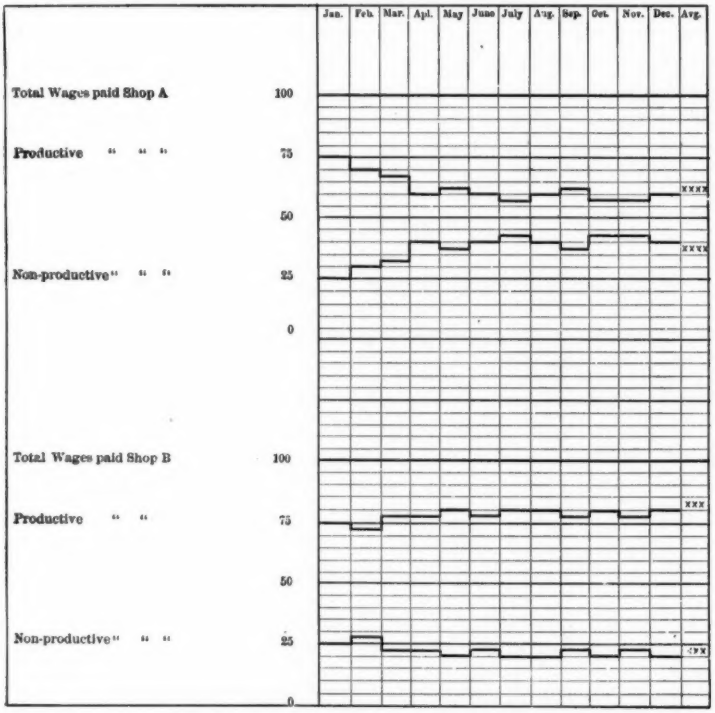
FORM V. CURVES BASED ON PERCENTAGES, SHOWING PERCENT. OF PROFIT ON OUTPUT OF TWO SHOPS.

the general management and for economy throughout, as well as an aid to purchasing and selling departments, and how its work may have a greater and more direct influence on the final outcome than is usually admitted, and it, in itself, prove a strong factor of success or failure.

At a recent convention of the Canadian Maunfacturers' Association the president said:

"I wish to emphasize the importance to our manufacturers of having skilled accountants. In our offices, we are accustomed to obtain the best help available to keep our accounts, regulate our credits, and attend to our banking; but in

the factory, where we deal with materials, time and machinery, waste, and wear and tear, all representing money, the same regard for skilled help is as a rule not observed; and indeed the services of skilled accountants capable of following all these items accurately and of keeping reliable cost accounts are difficult to obtain. In these days of keen competition it is highly important that the manufacturer should know to the fraction of a cent the cost of his goods."



FORM VI. CURVES SHOWING PROPORTION OF PRODUCTIVE AND NON-PRODUCTIVE WAGES PAID IN TWO SHOPS.

To this I would like to add that it is equally important to know to the fraction of a cent the details of the multitude of expenses, perhaps trivial in themselves, which yet affect the cost of production as much as, if not more than, the wages directly expended on manufacture, and also to know whether some of these various items of expense do not at times increase in a proportion not justified, or from some cause which might have been avoided if the effects had been foreseen.

THE EFFECT OF WATERWAYS ON RAILWAY TRANSPORTATION.

By S. A. Thompson.

Mr. Thompson's article needs no heralding. Its pertinence is manifest by the activity of interest in waterways everywhere—in Great Britain and on the Continent, concerning the general system of internal water transport; in America, concerning the Isthmian canal, which overpasses in importance every other engineering or transportation issue now presented to the world.

Mr. Thompson's argument establishes itself. The salient point is the demonstration of the fact—overlooked by narrow visions—that a serviceable water route benefits and develops not only the world at large—especially the commercial world—but still more directly the pre-existing agencies of transport which, on imperfect consideration, it might seem to threaten or to supersede.—THE EDITORS.

THE trip of the Oregon around Cape Horn showed with startling distinctness that an Isthmian canal would practically double the naval strength of the United States; no argument is needed to show the advantage of such a canal to the commercial interests of the world; and the investigations of the commission headed by Admiral Walker showed a practically unanimous opinion among the officials of the railway lines between the Mississsippi River and the Atlantic that the proposed Isthmian waterway would be beneficial to the roads under their control.

But no such agreement was found among the managers of the lines west of the Mississippi, and some of them, believing that the canal would work injury of the most serious character to the business of the transcontinental roads, have striven by every available means to prevent, or delay to the utmost, the legislation necessary to authorize its construction.

A Transportation Paradox. The controlling effect of waterways upon the rates of competing railways is conceded by every one who has given the slightest attention to the subject. This control arises from the fact that the carriage of freight by water costs so much less than carriage by rail—the average rate per ton-mile on the Great Lakes, for instance, being about one-tenth of the corresponding rate on the railways of the United States. As the Isthmian canal would affect a greater volumne of railway traffic than any other waterway

every constructed or proposed—with the possible exception of a ship canal from the Great Lakes to the Hudson River—it becomes a matter of the utmost importance to determine, so far as this can be done beforehand, just what effect will be produced thereby. While the controlling effect of competing waterways on railway rates has been generally recognized, another effect, of equal or greater importance, has been almost completely overlooked. For, paradoxical as it seems, waterways are not only the most powerful possible regulators of railway rates, but are also the most powerful possible promoters of the prosperity of railways with which they compete.

The best thing that could happen to every railway in the United States—or elsewhere, for that matter—would be to have a waterway paralleling every mile of its track, and the deeper the waterway, within reasonable limits, the greater would be the benefit derived by the railway. If the managers of the transcontinental American railways were really awake to their own interests, instead of opposing an Isthmian canal they would use all their influence in its favor. Nay more; if Congress should fail to act, the capitalists who control the transcontinental railway lines ought to underwrite a sufficient amount of bonds to secure the construction of an Isthmian canal, and to get it built at the earliest possible date, and this not as a matter of sentiment or patriotism, but as a cold-blooded business proposition. This opinion is based upon the fact that many instances can be shown in which the construction or improvement of a waterway has resulted in great benefit to competing railways, while not a single instance has come to my knowledge, in the course of a study of the subject covering many years, in which the result has been otherwise than beneficial. But as the unsupported opinion can have little or no weight, it will be in order to offer the incredulous reader a few of the facts upon which it is based.

Some Suggestive Figures. During the fifteen years in which improvements were being made on the River Elbe, in Bohemia, the river traffic, as a natural result of the deepening of its channels, increased five-fold. But the traffic on the competing railways increased still more largely, and the dividends on the main line, from Teplitz to Aussig, rose to 16 per cent. per annum. I know holders of American railway stocks who would be glad of a dividend half as great as that. A mere coincidence, say you? Well, possibly. But if it be, I have a fine lot of striking coincidences to submit for your consideration.

A report of a committee of the Senate of France shows that out of 196 waterways enumerated in the statistics of inland navigation, only

73 had, in 1887, a traffic of more than 70,000 mile-tons, and every one of these was in close proximity to railroads, while the Northern Railway Company, whose system traverses a region containing 43 per cent. of the boating capacity of France, was the only one that was not obliged to call upon the government to pay the interest guaranteed upon its stock.

"Made in Germany." Equally interesting and conclusive are some illustrations taken from the experience of Germany. The canalization of the River Main from Mayence to Frankfort was completed in the latter part of the year 1886. As a result of this improvement, which gave a channel vastly better and deeper than was before available, the river traffic showed an increase of 64 per cent. in 1887 and a further gain of 42 per cent. in 1888.

Frankfort is abundantly supplied with railroads, having among others an independent line on each bank of the Main all the way to Mayence. Did these roads go into bankruptcy or suffer a serious falling off in their traffic? On the contrary, their business increased 36 per cent. in 1887 and an additional 58 per cent. in 1888. Two years constitute rather a short time from which to judge of the permanent effect of this improvement, but fortunately Consul General Mason, from whose report the above figures were taken, submitted another report under date of December 10, 1897, from which it appears that the river traffic, which amounted to only 150,000 tons annually before the improvements were made, had increased to 700,000 tons in 1891, and to 1,693,112 tons in 1896, while the traffic by rail, which amounted to 930,000 tons in 1886, had risen to 1,400,000 tons in 1891, and to 1,639,229 tons in 1896, *being nearly double what it was ten years before, when the railways had a practical monopoly of the freight business of Frankfort.*

The greatest railway mileage in the world under one management is to be found in Germany, unless some of the recent "community-of-interest" arrangements in the United States are to be interpreted as constituting common ownership. On July 1, 1888, out of a total of 16,281 miles of road, 14,665 belonged to the German Government. Yet the Reichstag, in 1887, passed an act providing for the completion of nearly 1,500 miles of canals and canalized rivers, although there were then finished and in use 1,289 miles of canals and 4,925 miles of canalized rivers. Other improvements have been authorized and completed since the date named, until today Germany has over 9,000 miles of canals and navigable rivers, and there are nearly 18,000 miles of state-owned railways in Prussia alone. Does any one believe

that the German Government would expend millions of marks out of the national treasury for the construction and improvement of waterways, if the result would be to lessen the national revenues by reducing the traffic on the national railways? Or is it possible that the German Government does not know what it is about? Let us see. To quote from Consul-General Mason:

> "If further testimony on this general topic were needed, it would be found in the steady, growing prosperity of the railways of Prussia, which from their location are brought into the most direct competition with the principal waterways. During the fiscal year 1896-97 the Prussian railroads earned $247,381,970, and the budget estimate, always conservative, for the present year (1897-98) is $264,000,000 from the same source. This is considerably more than half the entire income of the Prussian Government, and after deducting all expenses of operation, repairs, construction, new equipment, interest on bonds, etc., *leaves a net revenue of* $52,122,000 *to be turned into the treasury of the State.*"
>
> "That a portion of this surplus should be devoted each year to extending the canal and navigable river system is in furtherance of a policy the wisdom of which time and experience have fully confirmed."

At Home and Abroad. The Manchester canal has hardly begun to pay its fixed charges as yet, but it has caused such a tremendous development of the trade and commerce of that city that new buildings have been erected by thousands upon thousands, and every railroad has been compelled to enlarge greatly its terminal facilities.

For a number of years the United States Government has been improving the navigation of the Great Kanawha River by a system of locks and movable dams. Two railroads run along the banks of this river, the Chesapeake & Ohio and the Kanawha & Michigan. The following table shows that the shipments of coal by rail have increased even more rapidly than the shipments by river. The figures show shipments in bushels from points below Kanawha Falls for fiscal years ending June 30:

YEAR.	RIVER.	RAIL.
1881	9,628,696	6,631,660
1886	17,861,613	13,958,747
1891	25,761,346	28,668,025
1892	26,787,888	30,844,100

No official record has been kept of the rail shipments since 1892, but a note from the resident engineer states that they have largely increased since that date.

The great cities of the United States are all situated on waterways, and the greater cities are without exception on the deeper waterways. The New York Central and its western connections, considered as

one system, is paralleled by a waterway almost every mile of the distance from New York to Chicago; and where else in the United States can be found such a succession of prosperous towns and cities, almost within sight of one another all the way, as along the railway system named? Instances could be multiplied without limit, but those given must suffice, and it is now in order to consider the reason for the results which have been shown.

The Reason Why. Speaking of the German transportation system, Consul-General Mason, from whom quotation has already been made, says:

> German statesmanship was among the first to foresee that the time would come when, railways having reached their maximum extension and efficiency, there would remain a vast surplus of coarse, raw materials—coal, ores, timber, stone and crude metals—which could be economically carried long distances only by water transportation, and that in a fully developed national system the proper *rôle* of railroads would be to carry passengers, and the higher classes of merchandise manufactured from the raw staples which the waterways had brought to their doors."

To the same effect are the words of M. de Freycinet and the French legislative committee to which I have also referred:

> "It is conceded that waterways and railways are destined not to supplant but to supplement each other. Between the two there is a natural division of traffic. To the railroad goes the least burdensome traffic, which demands regularity and quick transit; to the waterways gravitate the heavy freights of small value, which can only be transported where freights are low."
>
> "Waterways, by increasing traffic, are rather the auxiliaries than the competitors of railroads. In procuring for manufacture cheap transportation for coal and raw materials, *they create freights whose subsequent transportation gives profit to the railroads.*"

A study of the statistics of the St. Mary's Falls canal shows that fully nine-tenths of all the traffic to and from Lake Superior consists of raw materials, and the figures for other waterways show practically the same result.

The debates in the Senate of France in 1863-'65 resulted in the declaration that it is to the interest of the State to foster both railways and waterways. This principle was reaffirmed in 1872, again in 1878, and still again in 1889, when it was stated that experience had fully confirmed the predictions which had been made. They have certainly had wide experience with waterways in France, for they began building canals in that country more than a hundred years before Christ was born—and they have not stopped yet. The legislators of France have shown their faith by their works, for in that land, which is so much smaller than the single State of Texas, there has been spent

since 1814 out of the national treasury more than $750,000,000 on waterways and harbors, more than $700,000,000 on railways and more than $650,000,000 on wagon roads. Within the past few weeks the House of Deputies has passed a bill appropriating no less than $132,500,000 for the construction of canals and the improvement of rivers and harbors. And it may be remarked in passing that the people of France are quite as well informed as to the value of waterways as are their legislators, for when a *plebiscite* was taken some years ago to learn the popular feeling as to a proposed canal from Paris to Rouen, at an estimated cost of about $40,000,000, out of 345,000 votes cast only 13 were in the negative! It would seem to have been in order for some one to move to make it unanimous.

A Transportation Trinity. The truth is that there are three agencies of transportation, each of which has a fundamentally different function to perform in the commerce of the world, all of which are as essential as are the three sides of a triangle, and none of which can reach its highest possible efficiency unless accompanied by a symmetrical development of the other two. This trinity of transportation agencies is made up of the wagonway, the railway, and the waterway.

Of these, the wagonway is commonly considered to be subsidiary to the other two—and so it is, in the same sense that a foundation is subsidiary to the superstructure. And the waterway is commonly thought to be antagonistic to the railways—and so it is in a sense and to a certain degree. For the three parts are not separated one from another and hemmed in like lakes by rocky shores. Their fields of action overlap, and their elasticity is so great that they can readily conform to all the ever-changing conditions and needs of that complex thing called commerce. The wagonway, however, is essentially local, the railway continental, and the waterway world-wide, in its sphere of action, while the distinguishing characteristic of the wagonway may be called availability, as speed is undoubtedly the distinguishing characteristic of the railway and economy of the waterway. And in the last analysis these three will be found to be not competitors, but complements—not antagonists, but auxiliaries. No one thinks of hauling corn or wheat from Chicago to New York in a wagon, nor of building a railroad from the barn of every farmer to the nearest grain elevator; and it is in reality just as absurd and economically wrong for a railroad to haul low-grade raw materials where there is a deep waterway properly located and equipped to perform the service.

When traffic is carried by an expensive method when an economical method is available, it results in a loss not only to the community,

but to the agency doing the carrying, the facilities of which ought rather to be employed in the transportation of goods of higher grade. Some years ago the directors of the Great Western Railway, of England, being dissatisfied with the returns arising from the operations of the road, made an investigation which showed that the manager, who was trying to drive a canal out of business, was using 58 per cent. of the total equipment in a traffic which produced only 14 per cent. of the total revenue.

Facilities Create Traffic. One-sided views are always wrong views, and the railway managers who look only at the traffic which would be taken away from their lines by a waterway, and not at all at that which would be brought to them by the waterway, are as wrong and short-sighted as the mobs that destroyed power looms or harvesting machinery with the idea that fewer men would be employed. The surface roads in New York city desperately opposed the elevated roads, fearing that their traffic would be ruined thereby. But the surface roads are more profitable than before the elevated lines were built, and the latter possess an enormous and profitable traffic which it would have been utterly impossible for the surface roads to develop. The tonnage which goes around the Cape of Good Hope is as large now as before the construction of the Suez Canal, which means that the traffic of 8,000,000 tons a year passing through that waterway has been created thereby.

Not a tithe of the truth is told by the figures which have been given showing the increased tonnage on the Mayence-Frankfort railways since the canalization of the River Main, because those figures do not show the fact that this tonnage is of a higher grade and pays a much higher freight rate, and make no mention of the greatly increased revenues from passengers, express matter, and mails.

The first locks at St. Mary's Falls were opened in 1855, in which year the registered tonnage was 106,296 tons. The half-million mark was reached in 1863, and the one-million-ton mark was passed in 1873. In 1881, exactly coincident with the opening of a much larger lock, the northwest began to grow by leaps and bounds and the tonnage of the canal rose from 2,000,000 tons in 1882 to 9,000,000 in 1890 and to 16,000,000 in 1896. During the past five years, two more enormous locks have been in operation, one of them on the Canadian side of the river, and in this short time the tonnage of the canal has leaped up to nearly 28,500,000 tons. This colossal tonnage is simply a manifestation of the development which has taken place in the northwest, along with which has come the building of thousands

of miles of railroad, including two lines from the head of Lake Superior to the Pacific Coast. If by some cataclysm of nature the Great Lakes should be dried up, the enormous traffic now carried on their waters would not be divided among the railroads—it would simply cease to exist. The whole galaxy of cities from Buffalo to Chicago and Duluth would be overwhelmed in hopeless, irretrievable ruin, and the railroads could in no wise escape the general disaster.

A Glimpse Ahead. The development of the Northwest, which has come chiefly in consequence of the building of the locks at the outlet of Lake Superior, marvelous though it is, is but a faint and shadowy image of the development, similar, but multiplied a thousand fold, which will follow fast upon the completion of an Isthmian canal. Since it is "not mileage, but cost of transportation, that is the true commercial measure of distance," the continent will shrink until its eastern and western coasts are commercially but half as far apart, while yet no single acre of its wide expanse is lost. Manila, Yokohama, and Hong Kong will be brought close to New York, Boston, and New Orleans, while San Francisco, Portland, and Seattle will become neighbors of Liverpool, Antwerp, and Hamburg. Mines will be opened, deserts made to blossom as the rose beneath the magic touch of irrigation, towns and cities will spring up, and the western commonwealths grow populous and great, while the manufacturing cities of the eastern States, the cotton planters of the south, and the grain growers of the middle west, will find new and enlarged markets for their products. I can think of no portion of the United States which would not share in the benefits showered abroad by the construction of an Isthmian canal, but if I were asked to point out the interest which would receive the most abundant share of the benefits which would certainly accrue, I should, without an instant's hesitation, name—the railroads of the western States.

EDITORIAL COMMENT

THE conclusion of peace in South Africa was announced just as our June issue was published. It is peace upon terms the Boers could have secured at any time for months past, and doubtless would have accepted had the fighting burghers in the field been better advised—or less ill-advised—by the now entirely discredited representatives on the Continent. The end was inevitable, and to a certain extent was discounted long since by those immediately concerned in South African industrial development. But any condition of disturbance, and above all, disturbance of the peace, is paralyzing to developments dependent on sure and speedy communications, the employment of large bodies of workers, and the investment of great sums of capital in vulnerable machinery and equipment. The formal peace-agreement therefore means much for the industrial reorganization of the Transvaal.

Under equitable and enlightened rule, its future depends only upon its resources. It may be, as in the case of California, that agriculture will develop wealth in the colony beside which all the gold will seem a small sum. But for many years, at least, the gold mines will be the feature of commanding interest. Extreme importance therefore attaches to the *résumé* and forecast by Mr. John Hays Hammond, which leads this issue. No one has more thorough knowledge than he of every condition affecting the output of gold from the Rand mines. And never, probably, has so satisfactory a summary been presented of the history, economics, ore deposits, mining practice, and prospects of the Witwatersrand.

THE passage of the Spooner bill, putting the Senate squarely in favor of the Panama Canal, is a most encouraging evidence of the certain ascendancy of plain business sense over mere political partisanship. This is especially gratifying to THE ENGINEERING MAGAZINE, which has steadily, though at first in seemingly hopeless minority, advocated the Panama route as best from an engineering standpoint, and far the most useful to traffic when finished. It is curious that a struggle between two such motives should have been so hard a one in a country like the United States, which stands as the very type of hard-headed utilitarianism. The Panama route, clearly and vastly better than the other in point of length, of curvature, of lockage, of weather and rainfall conditions, of harbor facilities at both ends, of both certainty and facility of completion, of ease and cost of control and maintenance, of safety from volcanic and earthquake damage, of cost to build and of usefulness to commerce when built—this almost immeasurably better proposition has had to fight for its life against the witchery of a name—the sentiment of a misconceived idea. "Nicaraguan Canal" was so long used synonymously and interchangeably with "Isthmian Canal"—partly through misunderstanding and indifference and partly through clever promotion by an interested clique (since departed), that it seemed impossible for many earnest minds to comprehend the real facts. Every demonstration of the commanding merits of Panama drew forth fierce mouthings against that "sink of corruption." Some mysterious contagion

of evil infested the enterprise, by which the country would be diseased. It calls to mind the remark of an old servant, who was told to prepare the guest room for a visitor—a lady whose house, as Bridget knew, had shortly before been robbed. "Sure, ma'am," said she, "ye wouldn't be havin' her sleepin' here? She has burglars!"

If indeed the microbe of mismanagement lurks in every fair prospect wrecked by weak or dishonest hands, the United States has done ill to adopt the cause of Cuba or to enter the Philippines. Americanism has been the great cry of the Nicaraguan party—the only response to reason or argument. The most un-American of all acts would be to buy and install a far inferior tool, and leave the better one for a possible competitor. And that the Panama route is immensely superior for actual service of commerce is practically the unanimous verdict of practical men. To be more precise, it has the unqualified endorsement of the Isthmian Canal Commission, and the emphatic preference of every mariner to whom the question has been submitted.

Many of the worthy Senators seem to have quite overlooked the fact that the function of a ship canal is not merely to be constructed, nor even to have the American flag flying over its waters, but to give safe, economical, and speedy passage to shipping. Usefulness, sufficiency to traffic needs when built, should be the qualities most sought. Grant that the construction of the Nicaraguan Canal is "feasible"—the point on which many of them insisted. The fact that it would be nearly three times as long, as tedious, and as hazardous in passage, should alone make it a last choice—a choice only if the safer, shorter, easier Panama route is wholly unobtainable.

Senator Morgan luridly described the Panama Canal as an undertaking in which "labor and death had joined hands." That they have not done so in Nicaragua is chiefly because labor has never been there. Panama paid the price that was paid by every like enterprise of the same period. Now the cutting of the most disease-infested surface soil has there been finished; conditions have been studied; sanitary working quarters have been established; hospitals have been built and equipped. A large part of the price need never be paid again—at Panama. Senator Morgan would throw this away, and begin anew the inevitable death tax of tropical excavation work, in a region in which, Dr. Soper says, natural hygienic conditions are even worse than at Panama.

There is strong belief that the same progress of reasonable conviction which has so changed the attitude of the Senate in a few months has also affected the House, and that the Spooner bill may prevail there also. It is sincerely to be hoped this may be true, and that a measure providing for actual construction of an Isthmian canal may go to the President before the close of the session. Of all the childish and stupid statements made during the heated debate, the most ridiculous was that "a vote for Panama meant a vote for no canal"—that those opposed to any waterway, and especially the Transcontinental railway interests, were opposing the Nicaraguan route. If the Pacific railways really are so short-sighted as to miss the perception so clearly put by Mr. Thompson in these pages—if mistakenly they believe the canal would diminish their traffic by the amount of tonnage it carried—they should by all means work for the route which, by its difficulties, dangers, and delays of navigation would handle the minimum of tonnage; and that route is by the proposed Nicaragua Canal.

REVIEW OF THE BRITISH PRESS

Economics and Engineering.

IN the course of a recent editorial, *Engineering* strikes some fundamental facts in relation to the changes which modern engineering methods have wrought in the formerly accepted doctrines of economics, in a manner which will bear repetition and comment.

The old-time political economy of Adam Smith and his predecessors assumed a stable and lasting condition of social development upon which predictions could be based as in accordance with unchangeable laws. Much to the disgust of the professors and cabinet students of these important subjects, this comfortable state of affairs has been greatly upset, mainly by the action of engineers, an apparently irreverent and irresponsible set of interlopers, who ride rough-shod over ancient traditions in a manner altogether regardless of the fine old crusted traditions of their predecessors.

This action naturally extends over the entire world, but the industrial pre-eminence of Great Britain renders the effects more noticeable there than elsewhere. Says *Engineering:*

"The prospect is that in the future the efforts of the engineer will make the change more rapid, and will bring all the peoples of the world nearer and nearer together. If the alterations were to be all caused by British engineers and were to have their origin here, the future might be viewed with complacency. We should have first notice of the change, and should have time to adapt ourselves to it before other nations had clearly comprehended its significance. This is precisely what has occurred in the past. Speaking generally, all the great manufactures arose in this country, and although there were at times evils associated with them, as in the case of the factory system, from ignorance or want of forethought, yet on the whole the nation benefited immediately from the changes. "But the last few years have brought home to us the fact that we no longer have the complete pre-eminence we once had. Locomotives, steam engines, and machine tools come to us from America, electrical machinery from Belgium, chemicals from Germany, and so on. Our hands are not the only ones that grasp the rudder, and we have ceased to direct the course of nations exactly as we please. Other nations take a turn at the wheel at times, and we are carried on a course which is not of our own choosing. Change is always attended with inconveniences, even when it is directed by ourselves, but when forced upon us from without, and at inauspicious moments, it may be disastrous."

Since engineers have had such an important share in the modifications which have been made in practical economics, it has been urged that instruction in the science of economics should form a part of engineering education. Indeed it is this conclusion which forms the moral drawn in the editorial to which reference has been made above. At the same time it is evident that the most thorough training in the older schools of economics would have availed little in existing conditions, and it is altogether possible that an economic training based upon present conditions might be obsolete before the student had the opportunity to put it into practice.

The proper economic training for the engineer is not a logical system, entirely and rigidly correct in all its details, based upon premises of uncertain stability. Rather is it a full acquaintance with data and information concerning the industrial condition of the world at the moment, information available for prompt and powerful use upon demand and for practical ends.

"Economics involves the training of the judgment to grasp a great number of considerations of very diverse kinds and various values to set them in order, to

calculate the chances of some of them being wrongly appraised, and finally to arrive at a decision which represents the resultant of them all. For such a decision a man cannot have too much knowledge. There are people who form judgments intuitively, and probably they are the safest guides. But they are fewer than the positions which need such qualities. Responsibilities are thrust upon men who are not prepared by Nature to meet them, and for such the aids of education are most important. For them history, logic, and statistics are the best aids; and at this period of our national life it is the duty of the ancient universities to do all that is possible to help them to bear their part in the coming industrial struggle. We are on the eve of a commercial war in which we shall need all the generalship which can be attained. It is useless for British engineers to brace themselves, to fling off their conservative habits, to improve their methods and appliances, if the commercial men who control the sinews of war cannot bear their part with credit. How far the men who are the heads of the great enterprises which have been lately launched in America are skilled in economics, we do not know, but it is certain that they have at their side assistants who have most carefully digested the immense stores of statistics the government provides, and have drawn from them a theory as to the constitution and movement of the industrial world during the next few years, which is of immense value to their chiefs."

While the above is doubtless in great part true, it must also be remembered that in many instances the combinations of financiers and engineers which have become so evident in industrial affairs of late, not only gather and digest information to guide them as to coming events, but they also in great measure control those events. The old laws of supply and demand included the idea of a freedom for the action of natural laws which at the present time is often absent. Forces do follow the lines of least resistance, but it is altogether possible to create and control artificial resistances which may materially change the direction of the currents. A man must not only have the knowledge and the data, but he must have the power and the ability to control them, and not merely glide with the current. Instead of drifting with the stream, contenting himself with a thorough knowledge of all its shoals and currents, he should correct its channel to suit his own purposes and then proceed to navigate it in a full-powered vessel, with his own hand on the wheel.

Compressed Coking Fuels.

Good coking fuels have never been very plentiful and they are continually becoming scarcer, and hence various methods have been proposed for enabling satisfactory coke to be made from inferior grades of fuels. The most promising of these is that in which the coal is heavily compressed before coking, and from a paper presented before the Iron and Steel Institute by Mr. John H. Darby we abstract some account of the process and its results.

The idea of compressing fuel for coking purposes originated on the Continent, where many of the coals coked so indifferently that it was of the greatest importance to adopt any method that gave a prospect of improving the quality of the resulting coke. It had been observed that the coke produced from the lower portions of retort ovens, compressed by the weight of the superincumbent fuel, was superior to that produced from the upper portions of the charge, and this led to experiments in compressing the fuel by various means: first, by stamping in the oven by hand, in other cases by weighting the charge; and from this the practice of compressing in a box outside the ovens was gradually evolved, the stamped cake being afterwards moved out of the box into the oven by mechanical means.

A number of samples taken from coking fuels in various parts of Great Britain were experimented with. The degree to which slack may be compressed varies with its character, state of division, contents of moisture, and other conditions; and generally speaking, it was found that the weight of a given bulk of compressed fuel in an oven was 50 per cent greater than fuel charged in the ordinary way through the holes in the upper portion of the oven and levelled by hand. Taking, however, the side clearance that has to be allowed in introducing a cake of fuel into an oven, the net gain in weight that a given oven capacity would

hold varied from 25 to 30 per cent. in favour of compressed fuel. But it was found that the compressed fuel coked more slowly than the uncompressed, and the net gain in production of coke per oven finally amounted to between 10 and 12 per cent. in favour of the compressed charge.

To ascertain the difference in the character of the coke from compressed fuel compared with uncompressed, the weight of a cubic foot from a solid lump of coke was estimated, and it was found, in the case of three samples of fuel from Durham, that the average weight per cubic foot for uncompressed coke was 63.37 lb., and for compressed coke 80.88 lb.: for North Welsh uncompressed coke, average weight 56 lb. per cubic foot, compressed 60.57 lb.; South Yorkshire uncompressed coke 53.9 lb., compressed 57.9 lb.: West Lancashire uncompressed 58.0 lb., compressed 66.4 lb. It will be seen from the above figures that compressed coke is considerably denser, in addition to which other advantages were noted. These were (1) the breeze or small coke was very much reduced in quantity, the lumps of coke were larger and firmer, and in a marked degree bore handling without very much breakage; (2) the process of charging an oven by the mechanical means in use, where compression of fuel is adopted, occupies much less time than the old method of charging by hand through holes in the top of the oven; in fact, the time is reduced from 10 or 12 minutes to 3 or 4 minutes, so that the objectionable smoke is largely prevented, and the loss of by-products is less; in fact, in some cases the yield of ammonia has been increased 25 per cent.; (3) less hand labour is employed, and the laborious work of forcing the wet fuel out of the tubs into the ovens and leveling the charge in the ovens is entirely abolished, while the clearance between the cake of fuel and the side of the oven allows the free escape of the gases, and tends to prevent undue deterioration of the oven walls.

The process is especially intended to be used with retort ovens similar to the well-known Hoffman type, and the coal is compressed into large rectangular blocks about the height and width of the interior of the ovens, and slightly less in breadth. The slack coal is dumped into a framed box with hinged sides, and is rammed or stamped into it in layers about 18 inches deep, the stamping being performed by a rammer driven by an electric motor. When the box is filled with compressed slack the hinged sides are released by cams and the block, which is formed on edge, is pushed into the open oven by a ram, the operation being rapidly performed, and the oven quickly closed. The whole apparatus is mounted on a framework, carried on rails, so that it can travel along before the successive oven doors and charge them in order.

The process, as has already been noted, is especially intended for the preparation of inferior coals for coking, but it is also applicable to coals of good quality, the improvement being apparent in all cases. Even with the best coking fuels the results seem to justify the outlay in equipping a plant for compressed fuel, as well as the special case in which it is essential that the fuel should be compressed in order to produce a marketable coke.

By-Product Coke Ovens.

Among the papers presented at the recent meting of the Iron and Steel Institute attention may be called to that of Mr. J. Thiry upon the more recent improvements in the recovery of by-products in coke making.

The general features of the by-product oven, as distinguished from the common beehive oven are well known, consisting as they do in the coking of the coal in closed chambers, or retorts, and in delivering the distilled gases into coolers and condensers where the by-products are separated. The details of construction vary, mainly in connection with the heating of the air, the use of the gas as fuel, and the economical application of the heat. Much good pioneer work has been done in this line by Coppée, Simon, Otto, and others, and although there has always been a strong prejudice on the part of ironmasters against retort coke, this feeling is gradually giving way in the face of the evident advantages of the system.

Mr. Thiry describes as the latest type of by-product oven the Otto-Hilgenstock construction, in which the principal modifications over the Otto-Hoffman type appear in the method of using the gas as fuel.

The gas, after the by-products have been removed, is delivered back to the ovens and burned in Bunsen burners, the air supply being heated merely by passing through the flues beneath the ovens, thus dispensing with the necessity of employing any regenerator of the Siemens type. The hot products of combustion then pass to the steam boilers, where their heat is abstracted in making steam for the general purposes of the plant. The use of the Bunsen burners permits a very high temperature to be attained, an important requisite in the production of coke of high quality, the distribution of the heat being well under control, and the time required for coking being materially reduced.

The most important question in connection with by-product ovens is the market for sulphate of ammonia, since it is from the sale of this, the chief product, that the advantage of such ovens is mainly gained.

It has been urged as an objection to the adoption of by-product coke ovens that if such plants continued to be built in increasing numbers, the production of sulphate of ammonia would correspondingly increase, until the supply far exceeded the demand, thus rendering it difficult to find a market for the excess product. A general fall in price might then be anticipated, which would cut down any margin of profit, and makers of coke would then find themselves with an expensive plant left on their hands which could only be worked at a loss. With the object of ascertaining to what extent such apprehensions were justified, and being desirous of placing the true facts before the iron-makers, inquiries have been made, and an expression of opinion eventually elicited from the German Association for the sale of sulphate of ammonia as to the future prospects of the sulphate of ammonia industry, which may be regarded as quite trustworthy. According to this authority, the best evidence of the maintenance of prices in the future is afforded by a study of the published returns relating to the manufacture of sulphate of ammonia since 1895, and a comparison of the fluctuations in price corresponding to the state of the market for the same period. In the light of these facts it will, no doubt, be possible to refute, and, in fact, to dispel entirely, the groundless apprehensions entertained by those who are interested in this question. In Westphalia the production of sulphate of ammonia in 1895 was 10,043 tons, and it rose in the following year to 21,377 tons, with an average price of £7 18s. per ton. In 1897 the production was 32,418 tons, of the value of £7 13s. per ton. Throughout the succeeding years it continued to increase until, in 1900, it amounted to 49,223 tons, the price also gradually advancing until it reached £10 6s. per ton. Prior to the year 1895 the individual manufacturers sold their product independently, which renders it difficult to estimate the average value before that date. It may, however, be assumed that it fluctuated between £9 16s. and £10 6s.

On comparing the selling price of sulphate of ammonia with the quotations for Chili nitrates, it will be found that the former follows to a certain extent those of the latter, but the difference in the nitrogen contents of each—21.2 per cent. for sulphate of ammonia and 16.4 per cent. for Chili nitrates—must be taken into account. When it is further considered that about 1,300,000 tons of Chili nitrates are yearly produced and used, and, moreover, that sulphate of ammonia is a particularly suitable substitute for Chili nitrates as a fertiliser, for which purpose the latter is principally used, it is abundantly clear that only when the price of Chili nitrates is depressed will it be possible for a continuous backward tendency in the price of sulphate of ammonia to occur. The prices of Chili nitrates have, however, as a matter of fact, materially increased of late; and even if they decline, they can only fall in the most extreme case to level of £7 per ton, below which figure the production and preparation of nitrates would cease to be profitable. This would, however, be equivalent to a price of £9 5s. per ston for sulphate of ammonia, on taking into account the superior nitrogen contents of the latter. Further, it is possible that the nitrate fields will, according to the present available estimates, be completely exhausted in 23 years, provided the yearly production continues at the same level as in recent years—namely, 1,300,000 to 1,400,000 tons. Probably, therefore, the great need for nitrogen as a fertiliser will no longer be

sufficiently met, as at present, by the use of nitrates, and it will become imperative to increase very largely the production of nitrogen—that is to say, ammonia—for the purpose of satisfying the demand.

At the present time in Germany nearly 160,000 tons of sulphate of ammonia are used annually for agricultural purposes. In addition to this, the imports of nitrates in 1900 amounted to 484,543 tons, and in 1901 to 529,568 tons, which in regard to nitrogen are equivalent to 363,300 tons and 397,200 tons of sulphate of ammonia respectively.

The Evolution of Smokeless Powder.

RECENT military affairs in various parts of the world have drawn attention to the great advantages of smokeless powder in modern warfare, and hence an article in a recent issue of *Engineering*, upon the evolution of smokeless powder and other high explosives is of much general interest.

Common black powder, which is a mixture of nitre, sulphur, and charcoal, held its own against all other explosives as a propellant to be used in guns, and a bursting charge for shells, for several hundred years. It was simple, cheap, and easily made, and did not deteriorate with keeping, and it was quite strong enough for the guns which it was possible to make at that time. When black pawder is ignited, the oxygen which forms a part of the nitre becomes disassociated from the potash, and combines with both the sulphur and the charcoal. The sulphurous acid so formed in its turn combines with the potash which has been liberated, forming sulphate of potash, which appears in the air as a dense smoke.

When artillerists had arrived at the end of their tether, as far as black powder was concerned, they naturally sought something that would be stronger. Moreover, rapid-firing guns demanded that a powder should be found which was free from smoke. Gun-cotton in a compressed state, or in twisted cords, had been used to some extent, but had produced uneven results, and proved very unsatisfactory generally. However, a semi-smokeless powder was evolved which had gun-cotton for its basis, and which was extensively used in shot guns. This powder, however, was never very suitable for use in rifles.

When the Maxim gun first made its appearance, the amount of smoke which it evolved became very conspicuous. It was said at the time that one Maxim gun could pile up a cloud of smoke as big as St. Paul's in a few minutes. It therefore became obvious that if this gun were to go into use, it would be necessary to have something that would not produce this immense cloud of smoke, and very curiously the first smokeless powder suitable for use in rifles that seems to have been made was the result of experiments which were conducted for a totally different purpose.

The experiments of Maxim and MacRoberts, in 1885, upon a mixture of gun-cotton and nitro-glycerine, formed into cords, appears to have been the beginning of modern smokeless explosives, but the government prejudice against nitro-glycerine mixtures delayed the introduction of such combinations for military use. After various delays in litigation, however, the government modified its objections and the present explosive, well-known under the name of cordite, is admitted to be practically identical with the original powder made by Maxim and MacRoberts in 1886. The principal difficulty about such explosives, for there are several, differing mainly in the proportion of nitro-glycerine present, lies in the possible instability. The presence of too much nitro-glycerine prevents the powder from keeping, besides which it is apt to erode the bore of the guns with very great rapidity. The stability is improved by the use of a small quantity of vaseline, but the erosion produced is not diminished.

It soon appeared that the shape of the powder had an important influence upon its action.

When smokeless powder is employed in the form of a sphere or a cube, the cube burns smaller in all directions; consequently the surface on which the flame is operating is rapidly diminished in all directions. If, however, the powder is formed in long strips, the amount burning from the ends is immaterial; consequently the reduction only takes place in one direction—that is, in the diameter of the cord, and therefore the reduction of the burning surface is only half as rapid as it would be in cubes or spheres. When this same powder

is spun into tubes or flat sheets, the burning surface practically remains constant from first to last. In the case of a tube, if we do not take into account the length, which is immaterial, we shall find that the powder is burning smaller from the outside and larger from the inside; consequently the approximate area on which the flame works is constant.

The latest development in explosives for military purposes is found in the use of picric acid compounds for bursting charges in shells. Picric acid, chemically known as tri-nitro-phenol, is in itself very insensitive, and can be burned in large quantities without danger of explosion, but if properly confined and set off with a strong detonator, it produces disruptive effects more powerful than those due to dynamite. Sudden heating will also cause it to explode, and the elevation of temperature at the moment of the striking of a shell against armour plate is sufficient to set off the contained charge. By the addition of a small percentage of dinitro-benzol, a substance very similar to picric acid, the melting point, upon which the control of the explosion depends, may be materially lowered, and by the addition of a little vaseline a very effective and safe bursting explosive for shells is obtained. This bears the name of lyddite in England and melinite in France, the two explosives being practically identical.

Shells loaded with lyddite are provided with fuzes having a delayed action, in order to permit the projectile to penetrate the plate a sufficient distance before explosion. The arrangement of fuze used for this purpose is that due to Sir Hiram Maxim, in 1885.

He used a very strong fulminating charge placed at a considerable distance to the rearward of the projectile, and inclosed in a strong tube forming part of the projectile. This charge was so far removed from the main bursting charge that a premature discharge ruptured the tube and went off harmlessly inside the gun chamber. However, when the projectile struck the target and was retarded, the detonating charge moved forward as relates to the projectile, not only giving perfect safety, but at the same time the necessary delayed action, which would admit of the projectile passing through the plate. It will be understood that when the projectile struck the target, the fulminating charge entered the base of the projectile, and was sufficiently strong to open a communication from the inner tube to the bursting charge, thus igniting the main charge. This arrangement seems to be the only one with which any degree of safety has ever been obtained.

The experience in recent warfare has demonstrated the absolute necessity of using smokeless powder, and both in South Africa and in the Spanish-American war the smoke-producing black powder showed its utter unfitness for modern conditions of fighting. In like manner the destruction wrought by shells carrying bursting charges of lyddite showed the tremendous advantage accruing to the force supplied with such ammunition. Whether such additions to the means of destruction will aid in the prevention of war can as yet hardly be predicted, however devoutly it may be hoped.

Relays for Submarine Cables,

One of the most useful details of the electric telegraph is the well-known relay, in which the comparatively feeble electrical impulses sent over long telegraph lines are used to make and break the contacts in a relay circuit, thus enabling a local battery of suitable strength to operate the local receiving instrument. If such instruments are necessary in land lines, how much more are they to be desired in connection with submarine telegraphy, in which the currents, themselves very feeble, are sent thousands of miles beneath the ocean? As is well-known, the receiving instrument for a submarine cable is either the mirror galvanometer, in which the swinging of a delicately suspended mirror moves a reflected spot of light to the right or left, giving substitutes for the dot and dash of the Morse code; or else the Thomson siphon recorder, in which the vibrations are converted into a sinuous line, traced on a moving band of paper. Until the present time these two instruments have been the only ones which could be depended upon to receive the very feeble signals of the ocean cables with any commercial degree of reliability.

Naturally there have been numerous attempts to devise a relay, by means of which

the reinforcing action of a local battery could be called in to operate the receiving instruments, but the difficulties have been great. Any attempt to make a so-called "butt" contact good enough for the making of a relay circuit has been found to require more force than is practicable, while if a stronger relay current is tried the contact points are found to stick or cohere.

In view of these facts the paper recently presented before the Institution of Electrical Engineers by Mr. S. G. Brown, describing the achievement of this long sought feat, demands especial note and discussion.

Mr. Brown has brought to his aid a well-known fact in mechanics concerning the reduction of friction between two bodies when they are in motion. Thus a cylindrical rod, like a piston rod, fitted in a ring or collar, experiences a considerable frictional resistance to sliding motion endwise through the collar, starting from a condition of rest. If, however, the rod be given a rotating motion on its axis it is found that the frictional resistance to end-long motion is enormously reduced. Applying this principle to a cable relay, Mr. Brown makes his contact lever rest on a cylindrical drum, the surface of which is divided into three bands, the middle band being an insulator, and those on either side corresponding to the dot and dash contacts respectively. The drum is rotated at a speed of about 150 revolutions per minute, under which conditon it is found that a very small force is sufficient to swing the contact arm to one side or the other and throw the relay into action. Certain details are described by Mr. Brown, such as the introduction of condensers into the circuits, and the complete working instrument is shown and discussed at length.

The advantages of such an apparatus are self-evident. The usual methods employed on cables at the present time is to receive signals on a strip of paper, written by a siphon recorder, as a dotted ink line. The message at an intermediate station is then punched by hand on another strip of paper, which strip is passed through an automatic transmitter for re-transmission over the next line.

Sometimes, if the speed of signalling and the conditions of the circuit will allow of it, the message is read off the siphon recorder strip by the clerk directly as it flows from the instrument and sent on by a hand key, signal by signal. This latter system, called "human translation" is necessarily slow and laborious, and is permissible at but one station. By the introduction of a relay the human element is altogether removed, the messages being sent on automatically, whatever the speed of transmission may be.

Mr. Brown's system has been fitted to the cables of the Eastern Telegraph Company, and is in use at the station at Gibraltar for automatically transmitting messages over the cables between Porthcurnow, in England, and Alexandria, in Egypt.

In connection with this ingenious relay, Mr. Brown has also devised an apparatus which he terms an interpolator, and which is of great utility in increasing the transmitting capacity of submarine cables. This device is required when the highest possible speed is demanded, and as high speed is essential if the maximum amount of matter is to be transmitted, this has a vital commercial importance. When a cable is worked at high speed many of the originating impulses are obliterated from the received signals whenever successive impulses of the same polarity or sign occur. It is, therefore, evident that if the impulses sent by the relay apparatus into the second cable are to be identical with those of the first, it is necessary to restore the missing "beats." The instrument used for this purpose is called an "interpolator." Its action resembles that of the automatic transmitter at the originating station, with this difference, that the movements of its transmitting levers, instead of being governed by the perforations in the punched tape or strip, are governed by the motions of the relay tongue. The interpolator sends into the second cable impulses similar to those entering the first cable, and these may be either "curbed" or "plain" as required. To use this instrument to the best advantage, it is necessary that it should run in approximate synchronism with the automatic transmitter, and that the speed of the latter instrument should be nearly uniform.

It is admitted that these improvements of Mr. Brown's are the most important which

have been made in cable telegraphy in the past thirty years, and the manner in which their presentation was received by such experts as Professor Ayrton, Mr. Mordey, and others, indicates the value which this contribution to the transmission of intelligence possesses.

Electric Power in South Wales.

ALTHOUGH the inauguration of electric power distribution has been retarded in Great Britain, it appears at last to have taken a definite start, and with the laying of the cornerstone of the station at Pontypridd by Sir Frederick Bramwell, the work may fairly be said to be begun. From an account in a recent issue of the *Colliery Guardian* we abstract some account of this work in its immediate plans as well as its proposed future development.

The South Wales Electrical Power Distribution Company Limited was registered in 1900, with a capital of £30,000, for the purpose of obtaining an Act of Parliament. That Act was obtained and the present company was incorporated under a similar title, with a capital of £750,000, with power to issue £250,000 debenture stock. The company will provide and distribute electric energy in the county of Glamorgan, and that portion of the county of Monmouth lying west of the River Usk, thus comprising the entire coalfield of South Wales. The importance of the scheme will be understood when it is stated that the above-named district has an area of 1,034 square miles, and contains a population of over 1,000,000. The industries carried on in it consist of collieries, steelworks, tinplate and copper works, stone quarries, railways, tramways, engineering and ship-repairing works, chemical works, and factories of all kinds. There are over 2,400 collieries and factories, &c., large and small, in the district, and electric tramways are now being constructed or promoted in many parts of the area. All these, it is believed, will sooner or later adopt the use of electric power.

While the growth of the plant must be gradual, it certainly is situated in an excellent field for rapid development.

The total steam power at present installed in the district is estimated at considerably over 500,000 indicated horse-power, of which probably one-third could be immediately and profitably made electric. In the Rhondda Valley, and within a radius of six miles of Pontypridd, it is estimated there is 65,000-horse-power; within a similar radius of the Neath station it is estimated there is 60,000-horse power, and these amounts are constantly increasing. The Act of Parliament of the company contemplates, as a preliminary only, the establishment of a total horse-power for the district of 30,000—to be generated at three centres, Neath, Pontypridd and Pontypool; but eventually the number of stations will be increased to five, ground having been acquired at Bridgend and Cwmbran. At Neath work has been commenced on the foundations, and at Pontypool and Cwmbran sites have been selected, while at Bridgend the first instalment of the plant has already been delivered. Other generating stations are also contemplated by the South Wales Company. The buildings at Pontypridd, of which Sir Frederick Bramwell laid the foundation, when completed will be only one-fifth of the station as designed. Fifteen housand horse-power in engines, dynamos and boilers are now being provided for, but the stations will contain when completed no less than 75,000-horse-power, and no one unit will be smaller than 3,000 indicated horse-power.

The erection of even this preliminary portion of the plant will necessarily occupy some time, and hence it has been decided to install a temporary plant for immediate use. This will consist of two large locomotive boilers, four direct-coupled engine generator sets of 240-horse-power each, together with the necessary switchboard, pumps, and other accessories.

The growth of development of this plant will be watched with great interest, consisting as it does, of one of the largest steam power electric supply companies in existence. The great electric companies of other countries are mainly hydro-electric plants, notably those in Switzerland and in America. It has been argued in many instances that properly installed steam plants would be as profitable as those depending upon water power, and when the plant of the South Wales Company is in full operation some instructive comparisons as to efficiency and cost may be made.

Liquid Fuel for Locomotives.

We have referred elsewhere to the development of the petroleum resources of the Dutch East Indies, while the great production of oil in South-eastern Russia is well known. In a recent issue of *Le Génie Civil* the use of petroleum residues as fuel for locomotives is discussed, with especial reference to these same districts, and some data as to practical results may be of interest.

The locomotives under consideration may be divided into two classes: those intended primarily for the combustion of coal, the liquid fuel being considered as an auxiliary, and those in which no provision is made for any but liquid fuel. The general arrangement of the engines of the first class is shown by the devices already well-known in England as in use on the engines of the Great Eastern Railway, designed by Mr. Holden. In these the liquid fuel is delivered through burners placed above the fire door the jets being annular in form, the liquid being pulverised by the action of steam jets while heated air is at the same time delivered in the centre of the burner. The air is drawn in by the suction of the jet, having previously passed through heaters placed in the smoke box. If liquid fuel is to be used exclustively the steam pressure must first be raised by a fire of wood or coal, and the grate covered with broken fire brick to receive and radiate the heat, but in general the burners are used in connection with coal firing on the grate. Usually the liquid fuel is light enough to be readily pulverised by the action of the steam jets, but when heavier fuel, such as coal tar, is used, it becomes necessary to employ steam coils in the supply tank to render it more liquid. In the later designs of Mr. Holden the preliminary heating of the fuel is effected by the exhaust steam from the air-brake pump, thus avoiding the necessity for employing live steam.

In the engines built by the Chemnitz Locomotive Works for the State Railways of Java the Holden system is practically adopted, a coal-burning grate being provided as well as burners for liquid fuel. Since these engines are to be used in a tropical climate, provision is made for the ventilation of the fuel reservoir to prevent overheating in case naphtha is employed, while heating coils are also added for use with tar. A fire-brick arch is provided to protect the crown sheet of the firebox from the intense heat of the petroleum burners. These engines are intended to use the liquid fuel only as an auxiliary to coal, especially on long grades, or on any occasion when the steam pressure has fallen because of heavy demands for power.

The use of liquid fuel on Russian railways, however, has so far passed the experimental stage that powerful engines are equipped with oil burners alone, no provision whatever being made for solid fuel. Thus a heavy compound locomotive on the Mallet system is shown equipped with a cylindrical furnace without any grate, the lower portion of the furnace being filled with fire brick arranged to form flues through which the air passes before it meets the burning oil. These engines, of 81½ tons weight, are intended for hauling heavy freight trains weighing 500 tons, on the Moscow-Kazan and the Trans-Siberian Railways. The average consumption of naphtha is given as 14¼ litres per kilometre, or about 6.16 gallons per mile.

Another example of a Russian oil-fired engine is that of the compound express engines for the South-Eastern Railway of Russia, built at the Kolomna Iron Works, and intended to make a speed of 80 kilometres per hour (about 50 miles per hour). These engines, of a total weight of 63.2 tons, are two-cylinder compounds, with cylindrical fire box arranged for the burning of liquid fuel only, there being no grate. The experience which has been had in Southern Russia with petroleum and petroleum-resi-

dues as fuel has been so entirely satisfactory that there is now no hesitation in equipping engines for such fuel, without providing for grates in emergencies.

The Eastern Railway of France has introduced oil-burning engines in connection with solid fuel, the burners being intended for use in connection with the heavy grades between Paris and Belfort. Here the burners are introduced on each side of the fire box, the arrangement being that of MM. Vetillard & Scherding, in which the fuel, pulverised by a j t of steam, is delivered between two annular jets of air, thus insuring thorough mixture and complete combustion.

In view of the fact that liquid fuel can be so readily adapted for use with ordinary coal-burning locomotives, there seems to be no reason why such combinations should not be very generally supplied on railways where crude petroleum or petroleum residues are at all available, even though the entire change may not be contemplated. The consumption of fuel can be so perfectly regulated and accurately accounted for that there need be no reason for fearing waste, while at the same time such a reserve of firing capacity would enable lost time to be made up, or heavy grades to be ascended without the usual difficulties which are now encountered, when, for any reason, the steam pressure has been allowed to get low. The period of experiment is certainly past, and there is no apparent reason why such combinations should not become general.

The Düsseldorf Exposition.

We have already referred to the importance and interest of the Düsseldorf exposition, and now sufficient time has elapsed since the opening to permit some notice to be taken of the exhibits and their relation to mechanical progress. This is the more practicable since the exposition has distinguished itself from others by the remarkable feature of being ready at the appointed time, both as regards buildings and their contents. From interesting descriptions in the *Zeitschrift des Vereines deutscher Ingenieure* and in *Glasers Annalen* we abstract some notes concerning the exposition.

The grounds are situated on the banks of the Rhine, extending for about 1¼ miles north of the great bridge over the river, forming a strip a little less than ¼ mile wide, following the curve of the river. A large portion of the land has been reclaimed from what were formerly mud flats of the Rhine, and the whole has been improved and beautified in a very complete manner, the total area available being about 60 hectares (nearly 150 acres). On these grounds there have been erected 160 buildings, having a total value of about 10 million marks. Some of the structures are so constructed that they may be re-erected elsewhere for subsequent use, while the art building is intended to remain permanently.

Since the exposition is mainly representative of the industries of Rhenish Westphalia it is to be expected that the departments of mining and metallurgy should occupy a prominent position, and these, with the allied mechanical industries form the principal matters of interest. Besides the main buildings devoted to the departments there are special structures containing the exhibits of the larger establishments, such as Krupp, the Gutehoffnungshütte, the Hörde iron works, the Bochum works, and others.

Without attempting to discuss the entire exposition in anything but a most general way, the various technical journals are proceeding to take up various lines of exhibits and examine them in detail. First among such discussions naturally falls the subject of motive power, and in the *Zeitschrift des Vereines deutscher Ingenieure* we notice two articles by Herr Dubbel upon the boilers and engines at the exposition.

The steam generating department is a strong evidence of the popularity of the water-tube boiler, since eight out of the thirteen installations are of this type. The water-tube boilers are of well-known design, including the Babcock & Wilcox, Dürr, Gehre, Walther Steinmuller, and others. These call for little comment as to their construction, except as to the general adaptation of superheaters. A high degree of superheating, while now fully appreciated as a means toward better steam economy, can hardly be introduced at a general exposition, where the steam is to be used for various purposes, in engines of different designs, but such an extent of superheating as will effectually overcome the consequences of priming, may well be introduced, this permitting a high rate of evaporation to be attained without especial regard to the

dryness of the steam, the superheater being relied on to evaporate the entrained moisture. Under such conditions the superheater should properly be regarded as a part of the boiler, its surface included in the total heating surface of the boiler, and the total efficiency taken as that of the apparatus as a whole.

As might be expected in an exposition devoted so largely to the iron and steel industries, the workmanship on the boilers is excellent, the plates being of mild steel, all rivet holes drilled, and rivetting performed by hydraulic pressure. The steam pressures are carried as high as 14 atmospheres, (about 200 pounds per square inch), and automatic stoking is shown in connection with some installations.

The steam engine exhibits show very clearly the reversion from multiple expansion to compounding, there being but one triple-expansion engine, the 3,500 h. p. vertical engine of the Gutehoffnungshütte, nearly all the others being compound horizontal engines, and most of these having the cylinders arranged tandem. The valve gears show a tendency to replace the Corliss with the poppett valve, although the former is still used on low-pressure cylinders in instances where it has been replaced on the high-pressure cylinders by the lift valve. These modifications all show the influence of the use of superheating upon engine design, this also being apparent in the provision made for free expension and contraction, the supporting of overhung cylinders upon spring bearings, and the avoidance of large masses of metal exposed to the heat of the steam.

So far as governing is concerned, the requirements of the electrical machinery have been taken into consideration, and inertia governors are very generally used, including those of the Proell, Doerfel, Stumpf, and similar types.

Coming so soon after the Paris exhibition of 1900, it is not to be expected that any great novelties in engine construction are to be seen at Düsseldorf. At the same time there is an excellent display of the latest type of steam generators and motors, and there is little doubt that the best work of German builders is shown in a manner more convenient for examination than at a larger exhibition.

The Cleaning of Boiler Tubes.

THE extensive use of tubular boilers, especially those of the water-tube type, has rendered it necessary to provide some method for removing the scale and soot which accumulates, and much ingenuity has been given to the design of appliances for these purposes.

From a general review of the most effective methods and appliances, appearing in a recent issue of *Revue de Mécanique* we make some abstracts, which will give an idea of the present methods of dealing with the problem.

Various opinions have been expressed as to the effect of a deposit of scale upon the evaporative capacity of a steam boiler, and while the loss from this source is now believed to be less than was formerly supposed, it is still serious enough to demand attention, especially as the scale undoubtedly has an injurious effect upon the boiler. The extensive experiments of M. Couste have shown that the conductivity of scale is about one-sixteenth that of iron, so that the influence upon the evaporative capacity of a boiler can be fairly well determined. The effect of deposits of soot is not so well ascertained, but it is believed by some engineers that it is even more injurious than hard scale. The fire side of tubes also become partially covered with fine dust and ash, which unless removed, seriously affects the value of the heating surface.

Prevention is always better than cure, and it is most desirable that scale should be avoided by the use of pure water and soot diminished by the use of smoke preventing furnaces, but in the great majority of instances some method of removing deposits is found necessary to maintain the performance of tubular boilers at their best efficiency.

For fire-tube boilers, in which the water is on the outside and the gases pass through the tubes, various forms of brushes have been devised for removing the soot, these being usually provided with steel or brass wires, and in some forms so arranged as to be expansible, pressing forcibly against the interior of the tube. For Serve tubes, provided with internal ribs for extending the area of heat-absorbing surface, special brushes are made, with spaces corresponding to the position of the ribs. Steam jets are

also found effective for the removal of dust and ashes, but in most instances the soot is sufficiently adherent to require the employment of stiff brushing devices.

In the case of water-tube boilers the soot and ash is deposited on the outside of the tubes, and in general the use of steam jets is relied on to clean them, although some special forms of brushes have been made for the purpose. The tubes of economisers are fitted with scraping collars, either moved at intervals by hand, or kept in slow continuous motion by power.

It is the removal of hard scale, however, which gives the most trouble, and the practical difficulties only serve to emphasise the wisdom of preventing its formation whenever possible. Fire-tube boilers, in which the scale forms on the outside of the tubes, have the disadvantage of usually requiring the boiler to be entered to get at the tubes, but at the same time the deposit is more easily removed or broken away under these conditions than when, as inside of water tubes, a continuous arch ring is formed. The usual method is to enter the boiler and use picking tools and flexible band scrapers, operated by hand, but the inaccessibility of many of the tubes interferes much with the work.

The principal field of invention for tube cleaners is found in the water-tube boilers, in which straight tubes are used which can be opened at one or both ends, and into which a stout bar can be introduced to carry the tools or mechanism. The earlier devices for this purpose, operated by hand, consisted simply of various forms of scraping tools, some of them very ingenious, but all of them adapted for dealing with scale of moderate thickness and hardness only. The later appliances involve the use of power, an advance doubtless due to the ease with which portable electric motors can be attached and operated. With such cleaners a thick coating of scale can be removed in a few minutes, and with proper precautions, no injury to the tubes need be feared.

An ingenious combination of two functions for this work is found in the devices which use the power of water-pressure, or of compressed air, to operate the cleaning tools and at the same time drive out the loosened scale. These various devices are very effective, and by their use the interior of the tubes of water-tube boilers of the large-tube type may be kept free from scale to an extent dependent only upon the care and expense permissible.

It is a question whether the cost and labor involved in cleaning boilers would not, in nearly all instances be more effectively employed upon the purification of the feed water, than in removing the deposits resulting from the use of impure feed. Absolute purity is not required, and indeed corrosion would doubtless follow the use of perfectly pure water in steam boilers. At the same time it is possible to remove matter in suspension by adequate settling tanks, while the carbonates and sulphates may be precipitated by heat and separated by frequent blowing-off and straining in the purifying apparatus.

Boiler cleaning can take place only at intervals, and between these periods the evaporative efficiency of the boiler is steadily diminishing, and the fuel consumption increasing, and the loss from this cause should properly be included in the expense of cleaning if comparison is to be made between the cost of prevention and cure.

The Salvage of Wrecked Vessels.

A department of engineering work concerning which but little has been written is that relating to the appliances and methods for raising sunken vessels, or, when salvage is impossible, for the removal of the obstructions which the wrecks may offer to navigable channels. For this reason a paper recently presented before the Société des Ingénieurs Civils de France by M. Dibos and published in the *Mémoires* of the society, is found to contain much of interest.

M. Dibos divides the subject into two classes, the first relating to the raising of boats in canals and rivers, where the water is generally of moderate depth and comparatively smooth, and the second discussing the broader subject of the salvage of sea-going vessels on coasts and in harbors.

A source of danger in canals in which the barges leave but little clearance between their bottoms and the bed of the channel, is found in the projection of rocks or stones. A stone, washed into the channel and rolled along under the bottom of a deeply

laden barge, may become imbedded in the sole of the canal very firmly and at the same time project sufficiently to tear a leak into the bottom of the next heavily laden boat which comes along. Such cases may be avoided by careful protection of the channel, and in any case the raising of boats in such shallow channels may generally be effected by stopping the leak temporarily by canvas on the outside, and by some form of coffer dam within, after which the water may be removed by pumping. In such instances difficulties sometimes arise from the nature of the cargo, sand or coal getting into the suction pipes and interfering with the pumps, and sugar forming a sticky mass, clogging the valves. Strainers will generally afford protection against solid matter, while sticky materials may be stirred and kept sufficiently dilute to avoid trouble. In some instances boats loaded with lime or plaster of Paris have been sunk, and in the latter case the swelling and hardening material renders the boat a complete wreck, besides forming a solid obstruction to navigation removable only by the use of explosives.

Where pumping, or the use of portable cranes or derricks, is found ineffective success is frequently attained by enclosing the sunken boat with a coffer dam of timber. A modification of this method is found in the use of a sheathing extending the bulwarks of the ship above the surface of the water, and then pumping the entire structure out, the leaks having been temporarily stopped as well as practicable by divers. This plan, when employed in harbours and similar locations is necessarily combined with the action of the tides, and in fact these latter afford most effective auxiliary power in many instances.

The use of air bags, submerged and attached to the hull in a state of collapse, and then inflated by means of air pumps, is a method which has been employed with some success, although their use is attended with difficulties when attempted on a large scale. An ingenious modification, used by M. Dibos, and on an improved system by M. Matignon, is the use of collapsed bags containing calcium carbide. When these are properly secured to the sunken hull, a small quantity of water is allowed to enter through suitable valves, and the large volume of acetylene gas thus produced inflates the bags and furnishes the required flotation.

Naturally the most important apparatus of the salvage engineer consists of the various forms of floating derricks and cranes of high power and stability, these having been built as large as 100 tons capacity, and mounted on pontoons capable of enabling them to be used with a high degree of stability, even with ample overhang. Air-tight caissons are also important accessories in working operations, while powerful pumps, capable of delivering large volumes of water form essential elements of equipment.

M. Dibos devotes a large portion of his paper to a description of difficult operations of actual experience in the salvage of wrecked vessels, showing the importance of the right application of engineering principles to the work. In fact, like all other branches of maritime work, this has become mainly a matter of judicious engineering, employing machinery of special design, and involving a high degree of engineering skill in its use.

Some interesting suggestions are given as to lines along which improvements may be expected in this especial line of work. Thus the peculiar transparency of sea water makes it possible to determine the location of sunken bodies when viewed under favorable conditions. An observer situated at a sufficient height above the water is able to distinguish the position of a submerged body when it would be unobserved if the eye were near the surface. Attempts have therefore been made, with some success, to use captive balloons to assist in the discovery of the correct position for the commencement of operations, and much valuable time in exploration by divers is thus saved.

The Elastic Deformation of Materials.

In computing the resistance of materials on construction it was formerly considered permissible to assume that the materials were practically rigid, and the distribution of stresses was based upon such an assumption, allowance being sometimes afterwards made for the yielding allowable within the limits of the arbitrarily selected factor of safety. It is now understood, however,

that no material can be considered absolutely rigid, but that even the most resistent substances are elastic, and it is therefore required, not that no yielding should occur, but rather that such yielding should not produce stresses greater than the elastic limit, so that no permanent deformations may be produced.

At the same time it must be admitted that our knowledge of the elastic action of materials is yet very imperfect, and that the solution of practical problems becomes often difficult and uncertain.

This whole subject is discussed in an interesting manner in a paper by M. A. Mesnager, and published in the *Annales des Ponts et Chaussées*, from which we make some abstracts.

M. Mesnager first examines the principles upon which the elastic theory is based: namely, that the external forces or loads applied to a material are opposed by corresponding internal forces, and that the effects of these forces are independent in their action.

Taking these fundamental principles into account, M. Mesnager proceeds to deduce the conditions of internal equilibrium as well as the fundamental equations of elasticity. For this mathematical portion of the discussion the student must be referred to the original paper. For the present it may simply be stated that the theory shows that elastic deformations are directly proportional to the stresses, so long as the elastic limit is not passed, and that the deformations are independent of each other, even when the forces have not the same direction. It has also been shown, by M. Maurice Levy, that for problems in elasticity in two dimensions the internal efforts are independent of the co-efficients of elasticity, and hence independent of the nature of the material under consideration.

This last fact is of great importance, since it enables us to formulate general laws by experiments upon a limited number of substances; and it is to the portion of M. Mesnager's paper bearing upon this feature that especial attention is directed.

It is a well-known fact that when a piece of glass is examined by polarised light, using a pair of Nicol prisms as polariser and analyser, any internal stresses in the interior of the glass will appear as variations in the intensity and distribution of light transmitted. By arranging a pair of Nicol prisms so that their position at right angles is maintained while the glass under observation may be subjected to various stresses, the internal changes, due to changes in the action of external forces, may be studied. Taking these existing experiences, M. Mesnager has developed the apparatus, especially by the use of monochromatic light, so that it becomes an instrument clearly revealing the position and direction of the lines of force within the glass, thus enabling the theoretical conclusions to be tested experimentally in a very complete manner. Although the usual materials of construction differ from glass in many ways, the action of the forces is the same for all, and the manner of their distribution being definitely ascertained, their magnitude can readily be determined for any desired material.

A number of examples are examined and discussed in the paper, including such cases as those of beams uniformly loaded, and loaded at determinate points, also columns, and extended surfaces. For the details of the observations as well as the mathematical discussions showing their relation to the conditions of actual practice, the reader must be referred to the original paper. It is interesting to observe, however, that in nearly all instances the hypotheses upon which the elastic theory is based were confirmed. It appeared, however, that in many instances quantities which have been considered negligible should sometimes be taken into account, and that it is unsafe to assume that values which appear small in mathematical formulas may not, under certain conditions, become of much importance.

The data and results of M. Mesnager's investigations may well be made the basis for a revision of the existing formulas for the internal stresses in materials of construction, and also may serve to guide the constructor in the disposition of material and especially in the distribution and application of loads. Many formulas are based upon conditions of loading which rarely, if ever, are actually attained in practice. Thus, for example, the formulas for the strength of long columns are based upon the condition of axial loading, a state of affairs which is almost impossible of

attainment in practice, and which is frequently altogether ignored by the attachment of brackets and flanges for the very purpose of enabling heavy eccentric and irregular loads to be applied. The study of the influence of such variations from assumed conditions becomes possible by the aid of some such optical method as that employed by M. Mesnager, and the possibilities which the method offers for the scientific study of the internal behavior of materials are almost unlimited.

Petroleum in Java.

THE increasing importance of liquid fuel and the progress which has been made in methods for burning crude petroleum lends much interest to the development of petroleum fields in various parts of the world. In a paper recently presented before the Royal Institute of Engineers of Holland by Herr Lambrechtsen van Ritthem, and published in *De Ingenieur,* there is given a general review of the development of the petroleum industry in various parts of the world with some interesting account of the operations in the Dutch East Indies, especially in the residency of Rembang, Java.

Petroleum was known to exist in the Dutch West Indies as long ago as 1863, but the first borings were made in 1871, in the residency of Cheribon, but without much success. Borings in 1889, however, when carried to a depth of 121 metres, struck salt water, gas, and oil, the oil production reaching 34 litres per minute. Since 1890 the entire petroleum industry of the Dutch East Indies has been in the hands of the government company, and the development has been steadily pushed. In 1898 the output was 386 000 tons, or about one-twentieth that of the United States, and it has been increasing ever since.

Herr Lambrechtsen van Ritthem accompanies his paper with a number of photographs showing the spouting wells at Ledok, Semanggi, and elsewhere, and also the extensive refineries at Soerabaja, and these are ample evidence that the government is pushing the development of the industry most effectively. At the present time the commercial products of the Dutch colonies are composed mainly of coffee, sugar, and tobacco, but it is predicted, and with every evidence of truth, that petroleum will form a fourth, equal, if not superior in value to the others.

We have referred elsewhere in this issue to the use of petroleum as an auxiliary fuel on some of the recent locomotives of the State Railways of Java, but in view of the development of the Rembang oil fields, as well as the future possibilities of further discoveries in the Dutch East Indies, it is possible that the use of liquid fuel alone may become the practice in Java, as it already is employed on the railways of southeastern Russia, and on the Black Sea steamers.

The Action of Pump Valves.

IT has become well understood by hydraulic engineers that the principal difficulty involved in the operation of pumping machinery at high speeds and under heavy pressures lies in the prevention of shock, due to the inertia of the moving masses of water. The most satisfactory relief from such injurious action has been found in the mechanical operation of the water valves, the opening and closing being effected positively by mechanical appliances connected with the operative mechanism, instead of relying upon the action of the water. The mechanical operation permits high lifts and large openings with few large valves, instead of a number of small ones with small lift, while at the same time insuring prompt and quiet closing at such a timing as to produce the minimum variation in the momentum of the column of moving water.

Although the advantages are well known, and the method has been very successfully applied in practice, there has been a lack of definite information as to the exact behaviour of such valves. In a recent issue of the *Zeitschrift des Vereines deutscher Ingenieure* Herr Rudolph Schröder gives a very complete account of tests made upon certain pumping engines in which the valves were so arranged that they could be operated either mechanically or by the action of the water, and the result is the publication of definite quantitative data of much value and interest.

The investigations were made upon two different machines, one a vertical pumping engine at Rothenburgsort and the other a horizontal machine at Billwärder Insel,

both in the vicinity of Hamburg. Both engines were crank-machines, arranged to be operated at speeds of 40 to 50 revolutions per minute, the water valves being operated by connections to eccentrics on the crank shaft. The Rothenburgsort engine was one of those furnishing the water supply to the city of Hamburg, and operated against a pressure of 43 metres while the engine at Billwärder Insel takes the water from the Elbe and delivers it into the settling basins against a head of only 4.3 metres, so that the two machines serve to illustrate very different conditions of operation.

In each case the valves were so arranged that they could be operated mechanically or allowed to be operated by the water against a spring resistance, and the successive observations were taken as closely together as possible, so that but little change in the operative conditions could occur. The investigations consisted in recording the exact lift of the valves upon indicator drums operated by the motion of the pump plunger, diagrams thus being obtained which showed the exact lift at every point of the stroke. In this way the timing of the valves was obtained as well as the absolute lift, and the relative action of the two methods of valve movement compared very precisely.

The motion for the indicator pencils was obtained by means of light rods, resting on the valves, the motion being transferred to the outside of the valve chamber through rocking spindles operating through stuffing boxes. Great care was taken to eliminate the effects of friction as far as possible, and the general characteristics of the diagrams show a consistency in results which confirms their reliability and value.

The results are given in a large number of diagrams which will reward careful study. The lift of the valves is given on a full scale, since the total amount of lift is within the range of the height of the indicator drum, while the stroke, while reduced, is given on a scale sufficiently large to permit the relation of valve-lift to plunger position to be accurately determined.

The performances can only be fully appreciated by a careful study of the respective diagrams, but the general characteristics may be readily described and discussed. In the main the mechanically operated valves show a decidedly earlier time of closing than those operated by the action of the water, although a fuller degree of opening was attained. This is what might be expected, since the movement of the water column must necessarily change itself before it can affect the valves. It is just this action, however, which determines the inertia effects in the operation, and which limits the speed at which the machinery can safely be run.

Apart from the more satisfactory action as regards lift and timing, the investigations show a material economy in power in operating the valves mechanically. In any case a certain amount of power is required, but under high pressures, and at high speeds much more is taken when the water acts as the moving agent than when a positive connection is employed. The experiments at Billwärder Insel show a gain of 15 to 20 per cent. by the use of the mechanical operation over the ordinary spring valves, and similar gain is shown at Rothenburgsort. The questions of wear and tear also enter, and it is evident that the reduction in shock, due to the smoother action, must produce corresponding economy in this respect.

The most advantageous arrangement appears to be that in which the valves are lifted by the action of the water, and closed by mechanical action, using some sort of positive connection with the mechanism of the pump. This permits very light and elastic springs to be used, and if the valves are made as light in weight as possible the delay in opening, in response to the action of the water will be inappreciable. The closing, being effected positively, will be always definitely accomplished as the gear may be set, and this can be done so that practically no shock will be produced, and the minimum of resistance encountered.

The investigations are probably but the first of many which will be undertaken in the same direction, and it will be of interest to observe the results obtained from some of the deep mine pumps fitted with Riedler and similar valve gears. There is no reason why the indicator should not produce as great an effect upon pump design as it has in the improvement of the steam engine, but it is probable that its most effective application will be in connection with valve diagrams, rather than with the record of the operations within the cylinder.

REVIEW OF THE AMERICAN PRESS

The Standardization of Engine Tests.

NEARLY all tests of materials or machines are made for purposes of comparison, and hence it is most desirable that tests of similar things should be made under comparable conditions. For this reason the report of the committee of the American Society of Mechanical Engineers upon the standardization of steam-engine tests is a document of immediate interest, especially in connection with the discussions which accompanied its presentation at the recent meeting of the Society in Boston. At the outset it must be distinctly understood that the Society in no case "adopts" any course of action as having its authorization, but receives the reports of its committees and makes them public as the expression of the opinions of those whose names they bear. Nevertheless the various reports which the committees of the society have made from time to time have met with wide acceptance from the engineering profession in all parts of the world, and in nearly all cases have crystallized into standard practice because of their inherent merits.

The code which is included in the report of the committee is far too long to be given here entire, but the general principles on which it is based may be indicated and some comments made, the interested reader being referred to the complete paper for details.

In the first place the performance of a steam engine is made on a heat unit basis. This is eminently wise, since it is the only true basis on which a heat engine can be scientifically examined.

This does not interfere with the time-honored term "horse power" since the relation between the two is definite and simple. It is only necessary to know whether the horse power is indicated or brake, and we can express the economy of a steam engine in terms of the number of heat units consumed per hour per horse power (brake or indicated), and obtain proper standards of comparison. There are naturally other ways of expressing engine performance, such as the hourly weights of coal, gas, oil, or other fuel, or the weight of steam consumed per horse-power-hour, but these are all convertible into their equivalent heat-unit values.

In the opinion of the committee the heat consumption of a steam engine should be ascertained by measuring the quantity of steam consumed by the plant and crediting the total heat of the entire quantity with that portion rejected by the engine which is utilized and returned to the boiler. In such determinations the committee includes the entire equipment of the steam plant which is concerned in the production of power in the term "engine," believing that the use of the heat-unit standard renders it obligatory that the engine should be charged with the steam used by all necessary auxiliaries. While this may be logically correct, it is not always possible to do so, nor it is usually commercially satisfactory, since the various auxiliaries, such as condensers, pumps, etc., are frequently furnished by other makers than the engine builders. It appears to be most desirable that the various auxiliaries be tested separately in such a manner that the results may be summed up in a total, and at the same time be capable of independent consideration. Especially is this the case in view of the introduction of the independent central condensing plant, in which a number of engines discharge into one general condenser, having its own air and circulating pumps and operating independently of any of the engines from which it receives steam. Such a condenser is as much an independent piece of apparatus as is the steam generating plant, the one forming a positive and the other a negative pressure reservoir, the engine being placed between.

In the rules for conducting the trials it is recognized that tests are made for various purposes, sometimes to determine the fulfilment of a contract guarantee, at other

times to ascertain the working economy of the engine alone, and sometimes to determine the performance of the entire power plant, including the steam generating portion. The code for boiler testing, prepared by a committee of the society, provides fully for that portion of the latter test, and the present code completes the subject for formulating the rules for engine testing in a similar manner.

Without going too fully into details, we may comment upon some matters connected with engine testing which are suggested by the code. In the first place, the fundamental data depending upon the construction of the engine should be furnished by the maker when the engine is delivered to the purchaser, as some points can be determined far more readily during construction than afterwards. Thus the clearance is usually measured from the drawings, or by weighing the quantity of water required to fill the space when the piston is at the end of the stroke, either method being unsatisfactory. The water method, however, could readily and accurately be applied in the shop, and the true clearance at each end furnished to the purchaser for subsequent use at any time. A wire gauge showing the exact bore of the cylinder should also be furnished, and replaced by a new one should the cylinder at any time be re-bored. A correct indicator reducing motion should form a portion of every engine, being as necessary to a modern plant as any other part of the machine. A little forethought in providing valves and connections in the piping will enable the tightness, or otherwise, of the engine to be ascertained in a few minutes, when it might be necessary to perform much annoying work to determine the presence or absence of leaks under ordinary conditions. The present report will have done much to advance steam economy if it draws attention to the provision of proper testing facilities as a fundamental part of a steam plant, and renders frequent testing convenient and inexpensive.

While the report countenances the use of water meters, insisting only upon their proper calibration, the discussion showed that little reliance is placed upon meters as instruments of scientific precision. The only reliable method of measuring water for a test is that of weighing it; or, for very large volumes, the discharge of a properly calibrated orifice, under constant head, may be substituted.

Indicator diagrams should be taken very frequently, the instruments having been carefully calibrated, but it is not necessary that simultaneous diagrams should be taken from both ends of a cylinder since the law of averages provides fully for any slight variations, if enough diagrams are taken. Speeds are best taken by the readings of a counter during the entire test, the difference in readings divided by the number of minutes giving an average which is more reliable than any isolated counting.

An interesting question brought up in connection with the rating of steam engines is the proportion of overload which an engine should reasonably be expected to stand. It is undoubtedly true that a steam engine should have a certain reserve capacity, but too high an overload capacity renders an engine less economical than if it is proportioned more closely to its usual operating load. The committee recommends that when an engine is operating at its rated power at a given pressure there should be a sufficient reserve to allow a drop of at least 15 per cent. in the gauge pressure without a sensible reduction in the working speed, and to allow an overload at the stated pressure of 25 per cent. This matter, however, is one which can hardly be controlled, for mill owners are altogether too prone to throw on more and more load as business increases, and the overload limit gradually becomes encroached upon, and often attained as a constant working load.

Taken as a whole the report is an admirable one, and the weight of the names appended to it will assure for it an authoritative standing.

Steam Pipe Coverings.

THE loss of heat by radiation from pipes through which steam is flowing on its way from the boilers to the engine or other point of useful application has long been considered by the engineer as a matter requiring consideration, and in nearly every modern steam plant some form of pipe covering is employed to diminish this loss.

A great variety of materials has been proposed for use in this connection, and pipe coverings form a regular article of com-

merce in most places wheres team is used

The relative value of the different materials which have been used for pipe coverings has been a fruitful subject for discussion, but since the investigations of Ordway, a number of years ago, there has been no scientific investigation of the matter until the recent experiments of Mr. George H. Barrus, the data and results of which were presented by him before the recent meeting of the American Society of Mechanical Engineers. The method employed in the tests was that of measuring the condensation of steam occurring in the pipes protected by the various coverings, in comparison with the condensation produced under similar and simultaneous conditions in uncovered pipes.

"The condensation test furnishes a method which is entirely satisfactory, not only in its practical aspects, but in its scientific bearings. The heat radiated from a steam pipe causes a portion of the enclosed steam to be condensed, and the quality of heat-radiated is exactly proportional to the weight of steam condensed, this being a well established scientific fact. It is a matter of extreme simplicity to ascertain the quantity of steam which is condensed, for it is merely a question of weighing the resulting water on ordinary weighing scales. The quantity of radiated heat which the condensation represents is determined with equal facility by reference to the well established tables of the properties of steam. It seems quite unnecessary, therefore, to consider any other method of testing radiation from steam pipes, when the condensation method is so readily and accurately used, and when its results are determined with such reliability as to leave nothing further to be desired. A matter, of the first importance, moreover, is that this method determines the exact thing for which non-conducting material is applied to steam pipes, which is, the quantity of condensation prevented, and the saving of fuel which covering the pipes secures.

"Condensation tests require, first, that the steam supplied to the pipes, which are subject to test, shall be at the outset free from condensation; in other words, dry steam. They require, second, that all the water condensed shall flow by the force of gravity to some low point from which it can be readily and completely drawn off for measurement. They require, third, that the surfaces of the pipe within shall be continuously supplied with steam, and that no air held in suspension by the steam shall collect at any point and prevent its contact with the surface. They require, fourth, that the water of condensation drawn off from the apparatus, which under the effect of the pressure of the steam in the pipe is at a temperature much above 212 degrees, shall be cooled on its escape to the weighing receptacle, so as to prevent loss of water by evaporation. The apparatus used on these tests was so arranged as to accomplish all the objects noted."

Previous tests which have been made for the measurement of the efficiency of pipe coverings have been upon a rather small scale and for short periods of time, but these tests included surfaces from 60 to 100 square feet in area, and extended over a month of time, during eight or nine hours each day, so that the results may fairly be considered as representative of actual working conditions.

In the first place the condensation occurring in the bare pipes furnishes some interesting information in a general way, showing as it does, the rate of transmission of heat which may be expected in pipes of 2 and 10 inches in diameter, exposed to the air. With a difference of about 300 degrees F. between the temperature of the steam and external air, the mean of the tests showed a transmission of about 3.2 British thermal units per square foot per hour per degree F. This determination alone is a valuable addition to the constants of steam engineering, especially as it has been obtained under conditions closely similar to those obtaining in the heating of air by steam pipes, and it will doubtless prove very useful in future computations for steam heating appliances.

The pipe coverings tested included those in extensive use in modern engineering practice, including asbestos, magnesia, different kinds of air-cell coverings, as well as asbestos hair-felt, and the results are given both in the form of tables and as graphical diagrams. The most interesting thing about this portion of the paper is the slight difference which appears in the value of the different coverings, all of them indicating the great value of some form of cov-

ering, and showing the small choice existing between those tested.

Mr. Barrus calls attention to the fact that it has long been known that the most efficient covering, as regards merely the nonducting properties, is hair felt, and the tests showed that those coverings which approached the most closely to hair felt in physical characteristics gave the best results. The reason for the superiority of hair felt is the fact that this covering divides up and entraps the air which it contains in a better manner than any other material commonly used, and it is the nonconducting properties of confined air upon which the efficiency of the covering depends. The only reason for using other materials, therefore, is to obtain a higher degree of durability, and this, in connection with the cost, becomes the controlling factor in the choice of a covering.

Compared with the bare pipes, it appears that the efficiency of the various coverings tested was about 80 per cent., or in other words, the condensation of the steam in the covered pipes was only about one-fifth of that which took place in the bare pipes. Mr. Barrus gives some interesting computations as to the money value of the coverings, this manifestly being dependent to a certain extent upon the first cost of the covering and the life before renewal, but in all cases the gain due to the saving of steam is greatly in excess of the expenditure, and the showing is such as to convince any one of the great economy in providing the best possible covering for all exposed steam pipes.

Water-Tube Boilers.

ALTHOUGH it is admitted that the ideal design for a marine water-tube boiler has not yet been produced, the extent to which existing forms have entered into current practice is evidence of the merits of the system, broadly considered. In a careful review of the present types for marine service, compared with cylindrical boilers, by Mr. Ernest N. Janson, in a recent issue of the *Journal of the American Society of Naval Engineers*, the whole subject is treated systematically, and some interesting points developed.

As Mr. Janson well says, the present prominence of the subject is partially, if not largely due to the apparent failures of certain types, and hence a critical review of the details of construction of water-tube boilers is timely. In a water-tube boiler the methods of construction determine to a great extent the adaptability for marine service, since designs giving excellent primary results may be lacking in features necessary for useful life in service. There is no doubt that the present unsatisfactory condition of the water-tube boiler question in the British navy is largely due to the unsuitability of the type chosen for the first installations, and the lesson has been both expensive and annoying.

That the water-tube boiler is undoubtedly to be the accepted general type for naval service, is conceded, and the only points to be examined, therefore, are those which go to make up the most acceptable design, indicating the lines along which development and improvement may be expected.

The advantages of water-tube boilers over those of the shell of cylindrical type are distinct and undoubted. In comparison of the two types the difference between the items of weight, space, steam pressure, economy, and facilities for installation appear most notable. In regard to weight and space the water-tube type shows a notable advantage. As regards pressure, the limit in cylindrical boilers appears to be reached at about 210 pounds per square inch, although as high as 225 is being used. The water-tube boiler, on the contrary, has a very wide margin, and pressures can be carried with safety far beyond the requirements of the present style of marine engines.

The cylindrical boiler is generally credited with possessing a higher degree of economy than the water-tube type, but this is not altogether warranted. There is no reason why the water-tube boiler should not be fully as economical as the cylindrical boiler, and when such results are not attained it can usually be traced to some defect in the installation or operation. The water-tube type permits of the use of ample furnace space, and the employment of heated air supply is readily accomplished. Proper baffling will keep the temperature of uptake gases down to an economic limit, and with proper construction and care the loss from air leaks into the casing can be practically prevented.

Mr. Janson reviews in detail the construc-

tion of the principal water-tube boilers in the market, showing their merits and defects for naval use, and emphasises the importance of simplicity in construction, and convenience for repair and cleaning on shipboard, away from the shop or navy yard.

In the earlier history of the introduction of water-tube boilers into naval service, the natural conservatism of naval engineers led to the use of both water-tube and cylindrical boilers in the same vessel, the latter being employed for cruising and port service, and the former held in reserve for sudden demands for speed in action.

At the present time, however, there appears a tendency in the equipment of new naval ships, to install water-tube boilers to the entire exclusion of the ordinary cylindrical boiler. This is well shown by the progressive practice in the German navy, a service which has always been most cautious and conservative as regards changes in important details. At first the proportion installed was about 35 per cent. of water-tube boilers and the balance of the cylindrical type, while in the two latest German battle ships the water-tube boilers form 70 per cent. of the whole, and the last contemplated cruisers are planned for water-tube boilers throughout.

For cruisers and battle ships the large-tube type of boiler has been generally installed, although there have been numerous appeals in favor of the small-tube express types for this service.

Each type, however, appears to be adapted for a special service. The small diameter bent-tube boiler is considerably lighter in weight so long as it is arranged for service in torpedo boats, because the tubes, on the whole are made much lighter, as they can well afford to be, on account of the more limited service to be expected from this class of boats. The heating surface is also provided in more liberal proportions, owing to a possibly excessive amount of forcing; this, however, cannot be had without occupying additional space. This extra space is easily provided for in the class of boats mentioned, due to the usual arrangement of the boilers, they never being placed side by side. Should this class of boilers be chosen for large ships, their weights at once increase on account of the heavier tubes and larger drums required, and become almost as high as any type of large-tube boilers. Excessive forcing cannot be permitted in such service, and hence still more space will be required.

In addition to these disabilities, arising as soon as this type of boilers is made to fit the conditions to be met when used in large installations, the question of cleaning the boilers becomes of great importance. Every two or three days some of the boilers require to be laid up for this purpose, with attending inconveniences in the cruising routine.

The boiler for continuous working, with provisions for keeping it in an efficient state and with the least liability of being thrown out of commission on account of the failure of some of its more or less important appurtenances, is the type to be first considered, and these requirements can, apparently, better be met in types containing comparatively large and straight tubes. The matter of first cost should always be considered in connection with other important points, such as life of boiler, repairs likely to be required, and the economic results while in actual service, but if any one boiler possesses a decided advantage over another in these latter points it should be adopted without regard to its possibly extra cost.

Education and Engineering.

ENGINEERING education is a subject which has been thrashed out so many times that it seems as if little more could be presented at this time, but the subject of the presidential address of Mr. Robert Moore at the recent convention of the American Society of Civil Engineers consisted of a different phase of the question. That is to say, he emphasized the importance and even the necessity that the engineer of the twentieth century should be a man of broad general education as well as one well trained in his specialized profession.

"Until very recent years the engineer, as a man of learning, even in his own profession, has not been the peer of the clergyman, the teacher, the lawyer or the physician. In fact, speaking broadly, engineering has not been one of the learned professions. And for this the reasons are not far to seek. As a distinct profession, that of the engineer is much younger than those just mentioned, and, what is even more to the point, the sci-

ences which set forth the laws that govern the materials and forces of nature and underlie engineering works, are all of recent development."

Naturally the earliest engineers were the priests, following whom came the builders of the mediaeval cathredals, bridges, and castles, but in all these instances the engineering was a minor part of the knowledge of the individual. As time passed on the field expanded and the work became specialized, so that the engineer, as a rule, found that it required all his time to acquire his professional experience, and general education became a secondary consideration.

"The structures which the first engineers were called to build, while they demanded skill and courage and judgment, called for little of the learning found in books. Some practical skill in arithmetic and geometry, and, possibly trigonometry was the limit of the scientific knowledge required. Engineering was an art, and not a science, and the engineer was little more than a highly skilled workman. As in all the arts, the standard method of instruction was that of apprenticeship, in which by word and by example the master slowly transmitted to his pupil the art and mystery of his craft. James Brindley, builder of the first important English canal, was a cotter's son and served seven years as a wheelwright's apprentice. George Stephenson, builder of the first successful locomotive and railway, was eighteen years of age before he learned to read. Thomas Telford, builder of roads and bridges, and first President of the Institution of Civil Engineers, was the orphaned son of a shepherd, and served a seven years' apprenticeship as a stonemason. Smeaton and Watt were mathematical instrument makers, and both men of considerable training, but as engineers they were almost wholly self-taught."

With the development of scientific research and the applications of scientific methods to engineering the engineer must have a scientific training, and the growth of the modern engineering school is witness to the extent to which that side of the question has been developed. This is the branch which is fully and widely understood by the term engineering education. Beyond this, however, there is needed for the proper equipment of the engineer a broad training in the other departments of human knowledge.

"For we cannot know anything correctly except as we know its limits and its place in the general system of things. Even the place where we stand on the earth cannot be accurately located except by its co-ordinates of latitude and longitude, which define its position with reference to the whole globe. Every well trained professional man, therefore, must have, as part of his equipment, the broad outlines of general knowledge. He must know something of language and literature, of political science and of history, something of what the world's workers have done and of what its thinkers have thought, in order that he may correctly understand and evaluate the knowledge peculiar to his own calling. To know every thing about something, which is his business as a professional man, he must also know something about everything.

"A broad basis of general knowledge such as shall put the man in touch with all times and with all men must, therefore, precede the special knowledge of the technical school. Otherwise there may be much mastery of detail, a microscopic thoroughness, but not the firm grasp and clear insight which the broader training gives. In fact, if a choice must be made, it is better to shorten, or even to omit, the training of the technical school, leaving the man to supply this deficiency for himself, rather than to sacrifice the broader outlook and the wider sympathy which is given by the more diversified training in the outlines of general knowledge.

"It is safe to say, therefore, that in the new century he who aims at the highest success as an engineer must be a more learned man than his predecessor of the last century. He must be master of the strictly engineering sciences and as a basis and introduction to these he must have the wider training of the preparatory school and the college.

"For it must never be forgotten that for real success in any calling, be it that of the professional man or the man in political or commercial life, there is needed something which neither books nor schools alone can teach, something which is partly the result of inherited qualities and partly the result

of our daily contact with men and things, something which is the resultant of the reaction of cur inheritance upon our environment, and which we sum up in the word character. Before there can be real power in any walk in life there must, in addition to technical training, be energy, veracity, self-respect, courage and address. That is to say, before we can have the able engineer, or the worthy exemplar of any profession we must, first of all, and more than all, have a strong and worthy man."

Electricity in Naval Service.

THE paper of Mr. Walter M. McFarland, presented before the American Institute of Electrical Engineers, upon electricity in the navy, is of much value for many reasons, but space will permit an abstract of but one portion of the subject at the present time.

Mr. McFarland drew attention to the fact that under the present rulings the naval authorities in charge of electric apparatus still limit all electric machinery on shipboard to that operated by direct current. This practice he believes to be a mistaken one, and he emphasised the great advantages of alternating current apparatus on shipboard. These advantages are based upon the simplicity of the apparatus, and its ability to stand the difficult usage of naval practice.

From the very nature of things the electric apparatus is to a considerable extent handled by men without a great deal of skill, the chief of the Bureau of equipment having called attention to this fact in his recent reports. Now the induction motor, with its extreme simplicity and ability to stand abuse and neglect, seems much better adapted to the general run of conditions on board ship than the more delicate direct-current motor. With its ability to stand a tremendous overload and even temporary stoppage, it would answer for driving capstans and even steering gear, from which the direct-current motors have thus far been barred out. It would also seem admirably adapted for such work as driving the forced draft blowers for the fire rooms, which are usually located in almost inaccessible places and where the steam engines now used to drive them rarely receive adequate attention when the blowers are driven at full power.

The demand for direct current for search lights and similar special service could readily be supplied by a separate generator, but as this has been decided in any case, there can be no difficulty of that score.

Although induction motors are as yet barred from use on shipboard, there have been numerous successful installations of them on shore in naval stations. Thus at the ordnance proving grounds and powder factory at Indian Head, Md., induction motors have been used for about three years with entire success, their especial advantage in that connection being their freedom from sparking. At the Brooklyn Navy Yard alternating current generators are used with induction motors for the tools, the whole plant being an excellent illustration of the most advanced practice in the powering of a modern engine-building plant.

With these examples before the continual observation of naval officers, there is every reason to believe that the entire practicability of the induction motor will be demonstrated for use on shipboard as well as on shore, and it is the opinion of Mr. McFarland that the permission to use alternating current on the vessels of the United States navy would result in the installation of a greatly increased number of motors.

Liquid Fuel Combustion.

THE advantages of liquid fuel have been appreciated for many years, but the practical difficulties connected with its complete and economical combustion have delayed its use in many instances.

The usual methods of burning oil is to employ compressed air or superheated steam to pulverize the liquid and deliver it into the furnace in the form of an atomized mixture ot oil, steam, and air.

During the past few years, Mr. Charles E. Lucke has conducted some very interesting experimental work at Columbia University, and a paper containing his results was presented by Mr. R. H. Fernald at the recent meeting of the American Society of Mechanical Engineers.

The paper relates the details of a number of experimental methods which are interesting mainly in that they lead up to the very simple and effective apparatus which was finally adopted. Instead of vaporising or spraying the oil by any mechanical means, Mr. Lucke delivers the liquid fuel directly

into the mass of a body of broken rock, this rock having already been raised to a red heat by means of a gas flame. The hot rocks vaporize the oil, which burns as a gas, the heat produced sufficing to maintain the temperature of the rocks necessary to vaporize the oil thereafter.

In describing the action of this method, Mr. Lucke says:

"The air and oil impinge together on the hot mass, spreading out in constant velocity surfaces; the combustion takes place on that surface where the velocity is equal to the rate of propagation and in the passage the oil automatically vaporizes by contact with the same rocks which make the explosive fire possible, and all this happens without diffusion with the products of previous combustion. Thus the function of the rocks becomes complicated; first, starting with gas the explosive fire is made possible by their presence, and the result is the heating of the entire mass from top to bottom, the mass thus heated is a perfect vaporizer for the oil, which, fed with its air makes an explosive mixture and maintains the temperature of the rocks, the whole interrelated series of actions and reactions producing what I have named the 'explosive oil fire.'

"Were the proportions not explosive the interior of the mass would chill and the vaporization would stop. It is a very striking experiment to withdraw the nozzle from the intensely glowing mass of rock, of a properly working fire, and note the oil drip, drop by drop, giving off each time a dull red flash and a cloud of smoke, while the whole rock mass cools down; a re-insertion of the nozzle causes at once a resumption of the intense rapid high temperature combustion. And, secondly, by a simple change of proportion observe an instant cessation of the action, producing first smoke and then total extinction.

"It need only be remarked that with every oil tried the action was the same; and three fires side by side, burning respectively kerosene, cylinder oil, and linseed oil, showed no difference in action. The so-called residue oils leave no residue this way. The experiment of feeding the several oils successively through the same fire without interruption resulted in no apparent change of action."

In the original experiments fire brick was used, but the intense heat of the fire was sufficient to fuse the fragments together, and better results were obtained with magnesite.

This method of burning liquid fuel permits results practically similar to gas firing to be obtained under steam boilers, and in all kinds of furnaces, but the principal application which the designer had in mind was the direct combustion of for the construction of an internal-combustion engine working by increase of volume at constant pressure. In this connection it is interesting to call attention to the early experiments of Brayton along similar lines about thirty years ago. There seems to be little doubt that an efficient internal-combustion engine of the Brayton type may be made in the light of the experiments of Mr. Lucke, and the ability of such a motor to burn almost any kind of liquid fuel would be not the least of its advantages.

By adopting this method of burning liquid fuel it becomes practicable to maintain combustion in a closed vessel continuously, the air being supplied with the liquid fuel under pressure and the products of combustion, greatly augmented in volume, delivered into another chamber, from which they proceed to the motor. The pressure of air and fuel can be maintained by a pump driven by the motor, precisely as was done by Brayton, the pressure of compression being somewhat higher than the resulting pressure of combustion, this maintaining the flow of air and fuel.

The resultant products of combustion might be delivered to a double-acting cylinder engine, similar to an ordinary steam engine, or probably to better advantage they might be permitted to impinge upon the blades of a gas turbine of the de Laval type, this having the advantage of avoiding the use of a water jacket, and probably permitting a high degree of efficiency to be obtained. Many similar applications will doubtless suggest themselves, and future experiments will decide the details of construction.

THE ENGINEERING INDEX

THE ENGINEERING INDEX IS THE KEYSTONE OF APPLIED SCIENCE

The following pages form a DESCRIPTIVE index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world,—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

(1) The full title,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published.

We supply the articles themselves, if desired.

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Arch.

Design of a Concrete-Steel Arch Bridge. Daniel B. Luten. Explains in detail a method used by the writer during the past year in erecting 16 bridges, which is thought to eliminate some of the doubtful factors. 5600 w. Eng News—May 8, 1902. No. 48026.

Basel.

The Competition for the Middle Bridge over the Rhine at Basel, Switzerland (Der Wettbemberb um den Neubau der Mittlern Rheinbrücke zu Basel). Carl Bernhard. A well illustrated review of the design which received the second prize, a steel cantilever with a single architectural pier in the center of the river. 2000 w. Zeitschr d Ver Deutscher Ing—April 19, 1902. No. 48227 D.

Bridge Moving.

Moving the Ft. Wayne Bridge at Pittsburg. Illustrates and describes a movement made necessary by the necessity of erecting a new bridge of greater strength. 1800 w. Ry & Engng Rev—May 3, 1902. No. 47963.

Dams.

See Civil Engineering, Construction.

Loadings.

Specified Loadings for Railroad Bridges. Ward Baldwin. A list of loadings speci-

We supply copies of these articles. See page 651.

fied in 1901 by the railroads more than 100 miles long, in the United States, Canada and Mexico, and comparison with those specified in 1893. 2000 w. R R Gaz—May 2, 1902. No. 47943.

Luxemburg.

The Great Luxemburg Arch. Illustrates and describes this great arch now in course of construction. It has a span of 277 ft. 1500 w. Engr, Lond—May 2, 1902. No. 48057 A.

The Luxemburg Bridge from the View Point of an American Designer of Masonry Arch Bridges. Albert W. Buel. An illustrated article discussing features of the design and construction. 3700 w. Eng News—May 8, 1902. No. 48023.

Plate Girder.

Single-Track Plate Girder Railroad Bridges at Richmond, Ind. Illustrated description of the details of erection of some large plate-girder spans. 2200 w. Eng Rec—May 17, 1902. No. 48130.

Quebec.

The Quebec Bridge. E. A. Hoare. An illustrated description of the new cantilever bridge over the St. Lawrence near Quebec. 2800 w. Can Engr—May, 1902. No. 47915.

Skew Bridge.

A Heavy Double-Track Skew Bridge. Illustrated description of a 237-ft. truss bridge with solid floor. 1700 w. Eng Rec—May 10, 1902. No. 47998.

Suspension Bridge.

Cable-Making on the New East River Bridge, New York. A description of the method of laying the wires for a suspension bridge with cables 2,985 ft. long. 2200 w. Eng Rec—May 3, 1902. No. 47860.

Cable Making on the New East River Bridge. An illustrated description of this interesting work. Each cable will be composed of 7696 wires, and have a strength of 200,000 lbs. per sectional square inch. Describes the process of cable making, the changes introduced, and the system of anchoring the cables. 1400 w. Ir Age—May 8, 1902. No. 47965.

Thusis, Switzerland.

The Rhine Bridge of the Albula Railway at Thusis, Switzerland (Die Rheinbrücke der Albulabahn bei Thusis). A well illustrated account of a steel deck bridge, 269 ft. span, in Eastern Switzerland. Serial. 2 Parts. 3000 w. Schweiz Bauzeitung—April 12 and 19, 1902. No. 48272 each B.

CANALS, RIVERS AND HARBORS.

Breakwater.

The New Breakwater at Port Colborne, Ontario; Welland Canal Entrance. Describes extensive improvements being made by the Canadian government at the point where the Welland Canal leaves Lake Erie. Also gives briefly the history of the canal, with report of its traffic and existing works. Ill. 4500 w. Eng News—May 15, 1902. No. 48108.

Canals.

Canal Improvements in France. A project for internal improvement now being discussed, which may cost $193,000,000. 600 w. U S Cons Repts, No. 1337—May 9, 1902. No. 47991 D.

Canal Traction.

See Electrical Engineering, Power Applications.

Docks.

Floating Docks. Illustrates and dscribes details of the Bermuda dock and the Algiers dock. 1000 w. Engng—May 2, 1902. No. 48063 A.

Dredge.

Sea-Going Bucket Dredge "Hephaestos" with Floating Pipe Line (Seetüchtiger Eimerbagger "Hephaestos" mit Schwimmender Rohrleitung). E. Kleinrath. A well illustrated description of a dredge built by Smulders for service in China, with a pipe line for discharging the dredged material supported on iron casks. 1 Plate. 3000 w. Zeitschr d Ver Deutscher Ing—April 19, 1902. No. 48226 D.

Dry Docks.

Reconstruction of the Pontanion Dry Docks at the Brest Arsenal (Reconstruction des Formes de Radoub de Pontanion dans l'Arsenal de Brest par M. Adrian Hallier). G. Richou. An illustrated account of the work of enlarging and modernizing dry docks for large naval vessels. 1 Plate. 5000 w. Mem Soc Ing Civils de France—Feb., 1902. No. 48409 G.

Reconstruction of the Pontanion Dry Docks at the Brest Arsenal, France (Reconstruction des Formes de Radoub de Pontanion dans l'Arsenal de Brest). G. Richou. Illustrated description of enlargement and modernization of old dry docks for battleships and cruisers. 1 Plate. 3500 w. Génie Civil—May 3, 1902. No. 48287 D.

Floods.

General Discussion on the Discharge of Streams. On the influence of floods and protection from them. 4700 w. Pro Engrs' Club of Phila—April, 1902. No. 47845 D.

Isthmian Canal.

The Choice of Isthmian Canal Routes. John T. Morgan. Presents the advantages of the Nicaragua route, and disadvantages of the Panama route. 5600 w. N Am Rev—May, 1902. No. 47834 D.

The Conditions Governing the Panama and the Nicaragua Canal Routes. George S. Morison. An address before the Massachusettts Reform Club. States the ad-

vantages of the two routes in a general way, but favors the Panama route. Also discusses the reasons why a canal should be built. 6000 w. R R Gaz—May 9, 1902. No. 47967.

The Isthmian Canal. Briefly reviews the suggested routes, especially discussing the Panama and the Nicaragua routes, and the problems in connection with each. 5800 w. Locomotive—March, 1902. No. 48083.

The Proposed Inter-Oceanic Canal. The first of a series of articles discussing the present outlook of this project, the routes favored, causes of delay, and matters of interest connected with the undertaking. Sections of the Nicaragua route are given. 2500 w. Engr, Lond—May 2, 1902. Serial. 1st part. No. 48056 A.

River Improvement.

Improvement of the Black Warrior, Warrior and Tombigbee Rivers, in Alabama. R. C. McCalla. An illustrated article giving detailed description of work to cost about $5,000,000. 11500 w. Pro Am Soc Civ Engrs—April, 1902. No. 47826 E.

The Improvement of the Channels of the Delaware and Schuylkill Rivers by the City of Philadelphia. An illustrated article stating the projects, giving details of the work and of the methods and machinery used. Also discussion. 9800 w. Pro Engrs Club of Phila—April, 1902. No. 47844 D.

Spillways.

The New Spillways of the Pribram Reservoirs (Die Neuen Ueberlaufgerinne der Pribramer Hauptteiche). Julius Divis. An illustrated account of improvements to safeguard the dams and reservoirs at a large Bohemian silver and lead works and mines. 2000 w. Oesterr Zeitschr f Berg u Hüttenwesen—May 10, 1902. No. 48268 B.

Stream Gauging.

The Figdor Indicator for Measuring the Velocity of Water (Der Wassergeschwindigkeits-Indicator System Wilhelm Figdor). Illustrated description of apparatus for measuring the velocity of flow in streams. An electric circuit is closed at every revolution of the vane, and a train of wheels set in motion. A recording apparatus is also shown. 1500 w. Oesterr Wochenschr f d Oeffent Baudienst—May 3, 1902. No. 48220 B.

CONSTRUCTION.

Building Construction.

Erection of the New York Stock Exchange Building. Illustrated description of the method of building a steel frame so heavy that bridge erection methods had to be adopted. 2300 w. Eng Rec—May 24, 1902. No. 48193.

Setting Heavy Columns in the Hall of Records, New York. Describes the method of handling granite columns 4½ feet in diameter and 36 ft. long. 900 w. Eng Rec—May 10, 1902. No. 48005.

The New York Stock Exchange Building. Illustrated description of the heavy steel-work in a 150 x 150 ft. building having an unusual arrangement of rooms. 2600 w. Eng Rec—May 17, 1902. No. 48135.

Coal Pocket.

Steel and Concrete Coal Storage Plant. Franklin M. Bowman. The Lowell Gas Light Company's coal pocket is described in detail. It is fireproof. Ill. 2000 w. Trans Am Soc Mech Engrs, No. 0950—May, 1902. No. 47987.

Cofferdams.

Interlocking Steel Sheeting in Cofferdam Construction. Illustrates and briefly describes a new method of interest being employed in the construction of the substructure of the Randolph St. bridge in Chicago. 500 w. Ry Age—May 2, 1902. No. 47960.

Dams.

A Proposed New Type of Masonry Dam. George L. Dillman. States the definite requirements of masonry dams, and suggests a new type, according to these requirements, which will contain less masonry, for the same factor of safety, than any of the recognized "standard types." 2000 w. Pro Am Soc of Civ Engrs—April, 1902. No. 47825 E.

Description of a Dam and Accompanying Works Built for the Water Commissioners, London, Ont., at Springbank. J. A. Heaman. Description and drawings showing the nature of the works, which consist of a concrete dam, retaining walls, etc. 2500 w. Can Soc of Civ Engrs, Adv. Proof—April 24, 1902. No. 47832 D.

The Bohio Dam. Continued discussion of paper on this subject, by George S. Morison. Ill. 10300 w. Pro Am Soc of Civ Engrs—April, 1902. No. 47827 E.

Fire-Resisting.

Fire-Resisting Construction. R. Clarence Backhouse. Read before the Inst. of Archt's., N. S. W. Discusses methods of construction, especially aiming to find something inexpensive but effective. 3600 w. Aust Min Stand—April 3, 1902. No. 48160 B.

Foundations.

A Foundation Failure and its Reconstruction. Illustrated description of interesting work acomplished under difficulties. 1700 w. Eng News—May 1, 1902. No. 47940.

Some Observations on the Deep Pneumatic Work of the New East River Bridge Foundations. Edwin Duryea, Jr. A general description of special features of the work; the compressed air conditions, cais-

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son sinking, material encountered, temperatures, etc. 4500 w. Eng News—May 1, 1902. No. 47941.

Undermining the Decker Building, New York. Illustrates and describes the method used in carrying long sections of wall, 185 ft. high and weighing 12000 tons, by means of unusually heavy beams and shores. 2500 w. Eng News—May 10, 1902. No. 48002.

Masonry.

Graphical Design of Retaining Walls, Dams, Abutments and Bridge Piers with Plane and Curved Surfaces (Graphostatische Verfahren zur Directen Dimensionirung von Stütz und Staumauern, Widerlagern und Brückeupfeilern mit Ebenen und Gekrümunten Begreuzungsflächen). Josef Schreier. Grapical methods for masonry structures, with formulae and diagrams. 6000 w. Zeitschr d Oesterr Ing u Arch Ver—April 25, 1002. No. 48222 B.

Roads.

Highway Construction. E. R. Buckley. Discusses principally the character of the pavement to be constructed and the methods employed, but also considers other matters related to this subject. 7000 w. Jour Assn of Engng Socs—April, 1902. No. 48086 C.

Some Observations upon the Binding of Sand by Stone Dust. Halbert Powers Gillette. Outlines a theory that if correct would make it possible to bind clean sand with fine stone dust forming a macadam, and aims to show that such a phenomenon occurs. 1100 w. Eng News—May 15, 1902. No. 48115.

Streets and Roads. James H. McDonald. Shows the severe usage of the city pavements of the present, discussing the six pavements now generally adopted in large cities, and their construction. General discussion follows. 9500 w. Jour Assn of Engng Soc's—April, 1902. No. 48085 C.

The Selection of Materials for Macadam Roads. Extracts from a report by Logan Waller Page on the properties of road materials suitable for different classes of traffic. 3100 w. Eng. Rec—May 17, 1902. No. 48132.

Simplon Tunnel.

The Construction of the Simplon Tunnel (Der Bau des Simplon-Tunnels). Hr. Molsen. A paper before the Hamburg branch of the Verein deutscher Ingenieure, giving a general account of this great Swiss-Italian tunnel and its construction. 3000 w. Zeitschr d Ver Deutscher Ing—May 3, 1902. No. 48237 D.

Tunneling.

Construction of the Metropolitan Railway, Paris. Illustrated description of tunneling operations with and without shields, sometimes along the route of large sewers. 3400 w. Eng Rec—May 24, 1902. No. 48191.

MATERIALS.

Brickwork.

Experiments with a Division Wall (Versuch bezuglich der Standfestigkeit einer Scheidemauer). Karl Stigler. Illustrated description of experiments with a brick wall, where part was removed and part remained in place. 600 w. Zeitschr d Oesterr Ing u Arch Ver—May 2, 1902. No. 48225 B.

Cement.

The New Swiss Standards for Hydraulic Cements (Die Neuen Schweiz, Normen für Hydraulische Bindemittel). A comparison of the old standards for cement and cement testing and those recently adopted by the Swiss Cement Manufacturers' Association and Swiss Engineers and Architects Society. 2000 w. Schweiz Bauzeitung—April 10. 1902. No. 48274 B.

The Portland Cement Industry in Michigan. Its history as given by Prof. Israel C. Russell in the Annual Report of the U. S. Geol. Survey. 1200 w. Sci Am Sup—May 17, 1902. No. 48105.

Columns.

Resistance of Materials. The Stability of Loaded Columns (Résistance des Matériaux Etude sur la Stabilité des Pièces Chargées Debout). Gus L. Gérard. A mathematical discussion of the theory of long straight pieces under compression. Diagrams. 10,000 w. Rev Univ d Mines—March, 1902. No. 48418 H.

Exhibition.

Stone at the Royal Exchange Colonial Exhibition. Describes some of the noteworthy exhibits from various localities. 5400 w. Quarry—May 1, 1902. No. 48070 A.

Fireproofing.

Different Building Materials Considered as to Their Adaptation for Fireproofing and Fire Retarding Purposes. Adler Muller. Considers brick, terra cotta, concrete, cast iron, wrought iron and steel, stone, timber and wired glass. 3500 w. Ins Engng—April, 1902. Serial. 1st part. No. 47830 C.

Georgia.

The Mineral Resources of Georgia. Extract from a paper by Prof. S. W. McCallie giving information concerning the development of the quarrying industry, the valuable marbles, granites, etc.; the road building material is also reported. 3300 w. Stone—March, 1892. No. 48021 C.

Marble.

An experimental investigation into the Flow of Marble. Frank D. Adams. An

illustrated article indicating the methods employed in the investigation and the results attained. 2800 w. Can Engr—May, 1902. No. 47917.

Reinforced Concrete.

Canal Lining of Reinforced Concrete (Revétement en Beton de Ciment Armé un Plafond de Canal). An illustrated description of a lining for the bottom and sides of a canal at Epinal, France. 800 w. Génie Civil—April 26, 1902. No. 48286 D.

Computing the Strength of Concrete Steel Beams. Louis F. Brayton. Table for the moment of resistance of reinforced concrete computed according to theory "B" presented by Prof. Hatt, with explanatory notes. 500 w. Eng News—May 15, 1902. No. 48112.

The Boussiron System of Reinforced Concrete (Note sur les Constructions en Cement Armé Systéme Boussiron). J. Boussiron. An extended illustrated account of a reinforced concrete system using straight, round, rough iron rods. Serial. 1st part. 6000 w. Revue Technique—May 10, 1902. No. 48400 D.

Theory of the Strength of Beams of Reinforced Concrete. W. Kendrick Hatt. Abstract of a paper read before the Indiana Engng Soc. An illustrated article explaining different theories of the strength of concrete steel construction and comparing the results of computations from the same data following these different theories. 2500 w. Eng Rec—May 10, 1902. No. 47996.

Resistance of Materials.

New Methods in the Study of the Resistance of Materials (Neuere Methoden der Festigkeitslehre). S. Rappaport. A mathematical discussion of the resistance of materials and framework calculations, with diagrams. Serial. 1st part. 1500 w. Schweiz Bauzeitung—May 10, 1902. No. 48277 B.

Timber.

The Timber Resources of the Australian Commonwealth. Edward T. Scammell. Showing the claims of Australian timber to the favorable consideration of municipal, railway and marine engineers, architects, builders, and cabinet and artworkers. Also discussion. 14000 w. Jour Soc of Arts—May 2, 1902. No. 48073 A.

MEASUREMENT.

Loads.

Maximum Moments and Wheel Loads. Mathematical demonstration of problems in which combined loading is used. 1000 w. R R Gaz—May 23, 1902. No. 48323.

Surveying.

Mine Surveying. Paper presented at meeting of the Assn. of Ontario Land Survs. by Messrs De Morex and Silvester. Methods of obtaining accurate underground surveys and plans are considered. 2700 w. Can Engr—May, 1902. No. 47918.

Range Pole Surveying. H. F. Wilson, Jr. Abstract of a paper read before the Engng. Assn. of the South. Describes a rapid method of approximate surveying for a railway in Alabama. 1400 w. Eng Rec—May 17, 1902. No. 48131.

Transit.

Some Hints on Specifications for an Engineer's Transit. Prof. L. S. Smith. An illustrated article discussing the deficiencies of this instrument and the proper remedies. 3700 w. Wis Engr—April, 1902. No. 47821 D.

MUNICIPAL.

Paving Brick.

Comparison of Brick Tests and Street Wear. Charles Carroll Brown. A report of tests and trials of a number of brands of paving brick made in Detroit in 1898. Also tests of paving materials in Maryland. 1900 w. Munic Engng—May, 1902. No. 47835 C.

Pavements.

The New Specifications for Asphalt Pavements in New York. Extracts from specifications intended to allow free competition while restricting the choice of materials to those suitable for such work. 2400 w. Eng Rec—May 17, 1902. No. 48129.

Sewage Disposal.

Electric Sewage Pumps, Septic Tanks and Contact Beds at Fond du Lac, Wis. George S. Pierson. Gives general information regarding the city and its sewerage system, with illustrated description of the fine plant recently put in operation. 3000 w. Eng News—May 22, 1902. No. 48311.

Pittsfield Sewage Disposal Plant. Illustrates and describes the new system on the plan of intermittent filtration. 1300 w. Fire & Water—May 3, 1902. No. 47899.

Sewage Disposal at Collingswood, N. J. G. Everett Hill. Illustrates and describes a plant with a septic tank and four coke filters. 2200 w. Engng Rec—May 3, 1902. No. 47859.

Sewage Disposal at Fond du Lac, Wisconsin. Irvine Watson. An illustrated detailed description of a septic tank installation. 1700 w. Munic Engng—May, 1902. No. 47836 C.

The Action of the Septic Tank on Acid Sewage. A review of the experiments for 15 months made by Leonard P. Kinnicutt and Harrison P. Eddy on the work actually done by a closed tank, on sewage containing an unusual amount of iron salts. 3800 w. Eng Rec—May 10, 1902. No. 48003.

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The Intermittent Sewage Filters at Pittsfield, Mass. Illustrated description of a system of storage tanks, electric pumps and intermittent filters of 25 acres extent. 1300 w. Eng Rec—May 10, 1902. No. 48000.

See Electrical Engineering, Power Applications.

Street Cleaner.

New System of Street Cleaning. Illustrated description of a sanitary machine now in use in New York. 400 w. Sci Am —May 10, 1902. No. 48027.

WATER SUPPLY.

Filtration.

Filtration of River Water. Alfred J. Jenkins. Extracts from a paper read before the Assn. of Munic. & Co. Engrs. at Birmingham. Considers means adopted for treatment. Discussion. 5800 w. Jour Gas Lgt—April 29, 1902. No. 48079 A.

Reservoirs.

Automatic Regulation of Discharge from a Reservoir. F. Rigaud. Gives solutions of the question, with mathematical development of formula. 1000 w. Min & Sci Pr—May 10, 1902. No. 48098.

Stand-Pipes.

Wind Damage to Water Works Stand-Pipe at Lincoln, Neb. An illustrated account of the accident. 600 w. Eng News —May 15, 1902. No. 48111.

See also Civil Engineering, Miscellany.

Stream Gauging.

See Civil Engineering, Canals, Rivers and Harbors.

Wachusett Reservoir.

The North Dike of the Wachusett Reservoir, Metropolitan Water Works. Frederic P. Stearns. Reprinted from the *Pro. Am. Soc. of Civ. Engrs.*, from the discussion on the Bohio Dam. Description of the design and construction. 7800 w. Eng News—May 8, 1902. No. 48025.

Water Purification.

The Iron Coagulant Process at Lorain. Describes the method of preparing sulphate of iron for use as a coagulant with rapid filters. 1200 w. Eng Rec—May 10, 1902. No. 48001.

Water Softening.

The Kennicott Water Softening System. Illustrated detailed description. It consists in the addition of soda and lime solutions, supplemented by the sedimentation of the treated water. 2000 w. Eng News—May 15, 1902. No. 48109.

Water-Works.

The utility of subsiding Basins. Review of a monograph by W. Kiersted, giving the results of experiments on the classification of Missouri River water by sedimentation and coagulation. 2500 w. Eng Rec—May 17, 1902. No. 48134.

Wells.

Artesian Water Supply and Irrigation. W. Gibbons Cox. An account of the extent to which underground water has been utilized in the past, and suggestions for the fuller application. 2000 w. Engr, Lond—April 25, 1902. Serial. 1st part. No. 47886 A.

Well Driving. A. H. Eldredge. Considers the method of driving wells and connecting the pump suction. Ill. 1300 w. Mach, N Y—May, 1902. No. 47913.

MISCELLANY.

Cuba.

Engineering in Cuba. C. J. Carlson. An extract from a field order, dealing with the water and sewage systems of the army camp at Quemador, Cuba. Ill. 2000 w. Wis Engr—April, 1902. No. 47820 D.

Education.

The Engineer of the Twentieth Century. Robert Moore. Presidential address before the Am. Soc. of C. E. concerning the requirements for successful engineering practice. 3100 w. Eng Rec—May 24, 1902. No. 48188.

Engineering Society.

The First Fifty years of the American Society of Civil Engineers. Charles Warren Hunt. Briefly reviews the growth in members, character of papers, library, etc. 2900 w. Eng Rec—May 24, 1902. No. 48189.

Irrigation.

Irrigation in Roumania and Bulgaria (Bewässerung der Rustikalgründe in Rumänien und Bulgarien). Jan Blauth. An illustrated description of irrigating and rather primitive water-raising methods. 1 plate. 700 w. Oesterr Wochenschr f d Oeffent Baudienst—April 19, 1902. No. 48217 B.

Wind Pressure.

Competition for a Wind-Pressure Recorder (Vorschriften für den Wettbewerb zur Erlangung einer Vorrichtung zum Messen des Winddruckes). The terms of a competition for a wind-pressure measurer and recorder, held by the German Ministry of Public Works, and which closes April 1, 1903, at the "Deutsche Seewarte," Hamburg. 500 w. Technologist—April, 1902. No. 48414.

The Wind Pressure on Upright Cylindrical Tanks (Berechnung von Behältern auf Winddruck). Prof. Philipp Forchheimer. The mathematical design of standpipes with particular reference to wind pressures. Diagrams and formulae. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—May 2, 1902. No. 48224 B.

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ELECTRICAL ENGINEERING

COMMUNICATION.

Cables.

Automatic Relay Translation for Long Submarine Cables. S. G. Brown. Read before the Inst. of Elec. Engrs. Illustrated description of a system in use on some of the lines of the largest cable companies. 3200 w. Elect'n, Lond—May 16, 1902. Serial. 1st part. No. 48352 A.

Submarine Telephone Cable with Increased Self-Induction (Unterseeische Fernsprechkabel mit Erhöhter Selbstinduktion). C. L. Krarup. An account of measurements of experimental telephone cables having iron ribbon and iron wire wound about the copper conductor. 1800 w. Elektrotech Zeitschr—April 17, 1902. No. 48202 B.

Fire Alarm.

The Vienna Fire Alarm System (Die Organisation des Nachrichtendienstes der Wiener Feuerwehr). W. Chitil. An illustrated general review of the telegraphic, telephonic and automatic fire-alarm service of Vienna. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—May 9, 1902. No. 48245 B.

Space Telegraphy.

Fessenden System of Wireless Telegraphy. Report of the testing of this system at Roanoke Island, N. C., by the U. S. Weather Bureau. It differs materially from the Marconi system, especially in employing no coherer. 1500 w. Elec Wld & Engr—May 3, 1902. No. 47925.

The Genesis of Wireless Telegraphy. A. Frederick Collins. A record of the efforts and facts that are responsible for the spark-gap and coherer system of wireless telegraphy. Ill. 3800 w. Elec Wld & Engr—May 10, 1902. No. 48039.

The Scientific Basis of Spark Telegraphy. Abstract of a paper by Dr. A. Slaby, in the *Elektrotechnische Zeitschrift*. An account of the scientific basis of the writer's method of wireless telegraphy. 2000 w. Elect'n, Lond—April 25, 1902. Serial. 1st part. No. 47879 A.

Wireless Telegraphy Invention. A summary by Prof. Sylvanus P. Thompson published in the London *Saturday Review*. Also editorial. 1900 w. Elec Rev, N Y—May 10, 1902. No. 48037.

Telegraphy.

An Electric Picture Telegraph. Describes an improved electrograph instrument, giving illustration and sample of work, and explaining its operation. 1300 w. Eng News—May 1, 1902. No. 47939.

The Buckingham Long-Distance Page-Printing Telegraph. William Maver, Jr. An illustrated description of a system operating at a high rate of speed on the longest circuits, in which the messages are received on the ordinary telegraph blank, or on large sheets if desired. 6000 w. Elec Wld & Engr—May 24, 1902. No. 48373.

The Telegraph of To-day. J. C. Barclay. A letter favoring manual rather than automatic telegraphy except for emergency service. 1000 w. Elec Wld & Engr—May 24, 1902. No. 48374.

Telephone Switch.

Telephone Switch for the Moldau-Elbe Canal System (Telephon-Umschalter für die Fernsprechanlage der Moldau-Elbe-Canalisierung). Hans Mattausch. An illustrated description of the telephone system of the Moldau-Elbe canalization works particularly of a switching arrangement designed by the author. 1 plate. 4500 w. Oesterr Wochenschr f d Oeffent Baudienst—April 26, 1902. No. 48218 B.

Telephony.

Party Lines. Oscar M. Leich. Considers the difficulties encountered on party lines and describes the signaling systems used. 3000 w. Wis Engr—April, 1902. No. 47819 D.

DISTRIBUTION.

Alternating Current.

A Résumé of the Alternating-Current System. H. G. Reist. Considers the generators, motors, distribution, etc. 2500 w. Am Elect'n—June, 1902. No. 48305.

Blasting.

See Mining and Metallurgy, Mining.

Cable Tests.

See Electrical Engineering, Measurement.

Fuses.

Safety Fuses in Branched Circuits (Ueber Sicherungen in Vergweigten Leitungsanlagen). Prof. A. Sengel. A discussion of the proper placing of fuses in branch circuits which have more than one connection with main circuits. Diagrams. 1600 w. Elektrotech Zeitschr—May 1, 1902. No. 48207 B.

Graphical Calculations.

Some Constructions for the Graphical Calculation of Conducting Networks (Einige Konstruktionen zur Graphischen Berechnung von Leitungsnetzen). Bruno Soschinski. An extension and completion of some graphical constructions due to C. Hochenegg, with diagrams. 1200 w. Elek-

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trotech Zeitschr—April 24, 1902. No. 48204 B.

Polyphase.

Practical Polyphase Working. Dr. Louis Bell. Deals with the installation and operation of polyphase stations, with special reference to the power transmission work for which such apparatus is used. 3000 w. Am Elect'n—June, 1902. No. 48307.

Railway Feeders.

The Calculation of Feeders for Electric Railway Distribution Systems (Beitrag zur Berechnung von Speiseleitungen Elektrischer Bahnanlagen). Prof. A. Sengel. A determination of the most economical cross-section of feeding conductors, with formulæ and diagrams. 2000 w. Elektrotech Zeitschr—April 17, 1902. No. 48200 B.

Voltage Control.

The Synchronous Converter as Voltage Controller. M. Seidner. Shows by graphical treatment how these machines may be employed for indirectly regulating the voltage by changing the field of the converter. 2200 w. Elec Wld & Engr—May 3, 1902. No. 47923.

Wattless Currents.

Wattless Currents (Ueber Wattlose Ströme). C. P. Feldmann. A paper before the Electrotechnical Society of Cologne, discussing various phenomena of alternating current circuits having capacity and inductance. 4000 w. Elektrotech Zeitschr—April 24, 1902. No. 48206 B.

ELECTRO-CHEMISTRY.

Electro-Metallurgy.

Electrolytic Production of Metals, with Special Reference to Copper and Nickel. William Koehler. An interesting discussion of this subject, explaining the method of working, the reactions and the different processes in use. 4000 w. Can Min Rev—April 30, 1902. No. 47908 B.

The English Electro-Metallurgical Company, Limited. An illustrated account of the new works of a newly organized company, and their equipment, the methods employed, etc. 2000 w. Engng—May 16, 1902. No. 48358 A.

Treatment of Auriferous Ores. C. A. Mulholland. Read at meeting Sydney Tech. Col. Min. & Met. Soc. Discusses apparatus where the electro-solution and electro-deposition of the gold are effected in one operation. 2800 w. Aust Min Stand—April 10, 1902. Serial. 1st part. No. 48159 B.

Electromotive Force.

Researches on Electromotive Forces (Recherches sur les Forces Electromotrices). M. Berthelot. A theoretical discussion of chemical action and electromotive force, and comparison of calculated and experimental results with various combinations of materials. 4000 w. Comptes Rendus—April 14, 1902. No. 48423 D.

Storage Battery.

Design for a High-Capacity Storage Battery. J. C. Brocksmith. Working drawings with descriptions of details. 3000 w. Am Elect'n—June, 1902. No. 48309.

Water Electrolysis.

The Technical Electrolysis of Water (Die Technische Elektrolyse des Wassers). Victor Engelhardt. An illustrated historical and general review of processes for the electrolysis of water and the resulting production of oxygen and hydrogen. 6500 w. Zeitschr d Oesterr Ing u Arch Ver—May 9, 1902. No. 48244 B.

ELECTRO-PHYSICS.

Coherers.

The Mode of Action of Coherers and Auto-Decoherers (Remarques sur le Fonctionnement des Choéreurs et des Auto-Décohéreurs). O. Rochefort. A record of observation leading to the opinion that auto-decoherers can be made ordinary coherers by diminishing the pressure of the imperfect contacts. 400 w. Comptes Rendus—April 14, 1902. No. 48428 D.

Constants.

Physical Constants. C. I. T. Haussen. A simplified system of dynamic, caloric, electric, magnetic and other physical and chemical constants and calculations. Mathematical demonstration. 1500 w. Engng—May 9, 1902. No. 48184 A.

Duddell Arc.

The Theory of the Duddell Singing Arc (Quelques Remarques sur la Théorie de l'Arc Chantant de Duddell). Paul Janet. A mathematical discussion, with suggestion for obtaining alternating from continuous current by means of this arc. 300 w. Comptes Rendus—April 14, 1902. No. 48425 D.

Low Temperatures.

Electrical Phenomena at Low Temperatures (Les Phénomènes Electriques aux Basses Températures). M. d'Arsonval. An illustrated account of the liquefaction of gases, and electric, magnetic and other phenomena at very low temperatures. 8000 w. Bull Soc Internationale d Electriciens—March, 1902. No. 48403 E.

Radiography.

Walter's Rontgen Ray Apparatus. An illustrated description of the practical construction and method of working the apparatus devised by Dr. Walter, of Hamburg. 1700 w. Elec Rev, Lond—May 9, 1902. No. 48166 A.

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Spark Spectra.

Variations of the Spectrum of Electric Snarks (Variations du Spectre des Etincelles). B. Eginitis. An account of experiments, which show that with electrodes remaining the same, the spectrum of the electric discharge between them varies with the self-induction of the circuit. 600 w. Comptes Rendus—April 14, 1902. No. 48426 D.

GENERATING STATIONS.

Austria-Hungary.

Electricity in Austria-Hungary. Felix Horschitz. Describes important and interesting plants, showing what has been accomplished. Ill. 2200 w. Elec Wld & Engr—May 3, 1902. No. 47922.

Buenos Aires.

The Buenos Aires Electric Station of the German Transmarine Electric Company (Das Elektricitätswerk der Deutsch-Ueberseeischen Elektricitäts-Gesellschaft in Buenos Aires). H. Baehcker. An illustrated description of a large station for light and power, on the Rio de la Plata, Argentina. 2000 w. Elektrotech Zeitschr—May 8, 1902. No. 48212 B.

California.

S. K. C. Apparatus at Colgate. Edw. Heitmann and William Currie. Illustrated description of the principal electrical features of this power house, especially the generators. 6000 w. Jour of Elec—April, 1902. No. 48146 C.

Discussion.

The Isolated Plant versus the Central Station—Discussion at the Chicago Electrical Association. Report of a very interesting discussion on the comparative advantages of the two systems. 3200 w. Elec Wld & Engr—May 10, 1902. No. 48041.

Generator Sets.

Some Details of Direct-Connected Generator Sets. William H. Bryan. The usual division of responsibilities between engine and generator builders in the construction of direct-connected sets, is outlined. 2500 w. Trans Am Soc of Mech Engrs, No. 0951—May, 1902. No. 47988.

Hagneck.

The Hydro-Electric Station at Hagneck, Switzerland (Usine Hydro-Eléctrique de Hagneck, Suisse). Henry Martin. A well illustrated, comprehensive account of this large plant and the electric distribution system. 1 plate. 4500 w. Génie Civil—April 12, 1902. No. 48280 D.

Heating.

Central Station Heating. D. F. McGee. Read before the Iowa State Elec. Lgt. Assn. A description of the plant at Red Oak, Iowa, with discussion of points of importance to obtain success. 3000 w. Am Gas Lgt Jour—May 12, 1902. No. 48051.

Magnetic Reaction.

On Magnetic Reactions in Dynamos (Sur la Reaction Magnetique de l'Induit des Dynamos). N. Vasilesco-Karpen. A mathematical discussion of the effect of the induced currents in armature and armature windings. 600 w. Comptes Rendus—April 14, 1902. No. 48427 D.

Paris.

The Electric Station of the Eastern Paris Lighting Company (Installations Electriques de la Cie. Est-Lumiére). Henry Martin. A well illustrated description of a central station, sub-station and electric distribution system in the east suburbs of Paris. 1 plate. 4000 w. Génie Civil—May 10, 1902. No. 48288 D.

Recent Construction.

Recent Construction at the Atlantic Avenue Station of the Edison Electric Illuminating Company of Boston. I. E. Moultrop and R. E. Curtis. An account of some of the new features introduced and of the conditions under which they were developed. Ill. 7200 w. Trans Am Soc of Mech Engrs, No. 0944—May, 1902. No. 47982.

Rheostat.

See Electrical Engineering, Measurement.

Shawinigan Falls.

Water Power Development at Shawinigan Falls. Wallace C. Johnson. Abstract of a lecture before the Canadian Soc. of Civ. Engrs. Describes the work of development. 4200 w. Can Engr—May, 1902. No. 47916.

South Wales.

Electric Power Supply Scheme for South Wales. An account of the engineering features of a scheme for supplying electric energy over an area of about 1,034 square miles. 1600 w. Ir & Coal Trds Rev—May 2, 1902. No. 48068 A.

Spain.

Hydro-Electric Station near Madrid (Proyectos de Santillana). A comprehensive, illustrated review of a 2000 H. P. hydro-electric plant which will transmit energy to Madrid and other places in the vicinity; projected by the Marquis de Santillana. 18000 w. Madrid Cientificos Supplement—April, 1902. No. 48299 D.

Speed Regulation.

See Mechanical Engineering, Steam Engineering.

Switzerland.

Some Statistics of Swiss Electric Stations (Einige Zahlen betreffend die Schweizerischen Elektricitätswerke). Prof.

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W. Wyssling. A statistical review of Swiss electric stations of all kinds, principally driven by water power. Serial. 1st part. 1000 w. Schweiz Bauzeitung—May 10, 1902. No. 48276 B.

Transformers.

Transformer Testing by Central Station Companies. R. F. Schuchardt. Practical information of testing methods which are rapid and sufficiently accurate. Gives a table of average results from transformers. Ill. 2300 w. Elec Wld & Engr—May 17, 1902. No. 48149.

Wales.

Electrical Enterprise in Wales. Describes the plant of the South Wales Electrical Distribution Company, summarized from an article in the South Wales *Daily News*. 1500 w. U S Cons Repts, No. 1344—May 17, 1902. No. 48084 D.

Whitehall, Ill.

A Progressive and Profitable Small Central Station. J. R. Cravath. An illustrated detailed description of the plant of the Whitehall (Ill.) Electric Co. 3400 w. Am Elect'n—June, 1902. No. 48303.

LIGHTING.

Arc Lamp.

A New Type of Continuous Current Arc Lamp. Frank Lewis. Illustrated description of the lamp and its action. 900 w. Elec Rev, Lond—May 2, 1902. No. 48081 A.

Cincinnati.

The Cincinnati Gas and Electric Company. Illustrated detailed description of the generating station and its equipment, the territory supplied, lamps, etc. 5200 w. Elec Wld & Engr—May 17, 1902. No. 48147.

The System of the Cincinnati Gas and Electric Company. L. G. Lilley. Illustrated description of a fine modern electric lighting system. 3000 w. Elec Rev, N Y—May 17, 1902. No. 48143.

Incandescent Lamps.

The Birth of a Glow Lamp. An illustrated description of the processes involved in the manufacture. 3200 w. Elec Times—April 24, 1902. No. 47868 A.

The Incandescent Electric Lamp—How Manufactured and Tested. William A. Del Mar. An illustrated description of the processes employed by a large European manufacturer. Also gives variations of the process introduced by other makers. 2700 w. Sci Am Sup—May 24, 1902. No. 48301.

The Manufacture of Glow Lamps. An illustrated detailed description of their manufacture and testing. 1800 w. Elec Rev, Lond—May 9, 1902. Serial. 1st part. No. 48167 A.

An Incandescent Lamp Test. J. D. Nies. A report of tests covering six makes of lamps. Diagrams. 500 w. Cent Sta—May, 1902. No. 47969.

Municipal Lighting.

Municipal Electric Lighting in Chicago. I. Report of Haskins and Sells, the result of an investigation into the finances of the plant. II. Economic and Social Factors in Chicago Municipal Lighting. John R. Commons. The general conclusions favor the municipal plant. 7000 w. Munic Af—March, 1902. No. 47893 D.

Nernst Lamp.

Tests on the Nernst Lamp. R. P. Hulse. Paper read at Birmingham, Eng., March 19, 1902. Describes the tests made of the 1902 model, giving diagrams. 1800 w. Elec Rev, Lond—April 18, 1902. Serial. 1st part. No. 47877 A.

The Nernst Lamp. Murray C. Beebe. Abstract of a paper read before the New England Cotton Mfrs. Assn. Describes the commercial and automatic lamp as recently developed. 1200 w. Ir Age—May 29, 1902. No. 48375.

Rates.

The Flat Rate Nuisance. Thomas D. Miller. Read at meeting of the Southwestern Gas, Electric and Street Railway Assn. Condemning flat rates as applied to the lighting business. 1600 w. Am Gas Lgt Jour—May 12, 1902. No. 48050.

Suburban.

A successful Suburban System. Alton D. Adams. Describes the territory served by the Malden Electric Company, near Boston, the plant, etc., the number of incandescent street lamps supplied being larger than any other plant in the state. 2000 w. Elec Wld & Engr—May 17, 1902. No. 48148.

The Bergen County, N. J. Lighting System. W. J. Jones. Illustrated description of a system furnishing current for street-lighting, commercial lighting and power to thirty-eight municipalities, which comprise about fifty different towns and boroughs, covering about 160 sq. miles. 1400 w. Elec Wld & Engr—May 24, 1902. No. 48372.

Supply.

Electric Lighting by Street Railway systems. Alton D. Adams. Discusses the movement looking to the supply of electric light from street railway stations, showing its desirability from the standpoint of the general public. 1700 w. St Ry Rev—May 20, 1902. No. 48340 C.

Western Plants.

Some Typical Western Electric Lighting Plants. Brief Illustrated descriptions of interesting details in what may be regarded as typical installations. 1200 w. Elec Rev, N Y—May 24, 1902. No. 48336.

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MEASUREMENT.

Cable Tests.

The Testing of Electric Cables (Note sur les Essais des Cables Electriques). P. Charpentier. A paper on the testing of heavy current and high tension cables. 10000 w. Bull Soc Internationale d'Electriciens—March, 1902. No. 48404 E.

Compensated Meters.

Magnetically Compensated Ampere- and Voltmeters (Nouveaux Ampèremètres et Voltmètres Indépendants de leur Aimant). An illustrated description of continuous-current meters, which are compensated for variations in their permanent magnets by a small piece of soft iron inside their coil. 2500 w. Bull Soc Internationale d Electriciens—April, 1902. No. 48405 E.

Current Density.

The Current Density in Resistance Wires (Ueber die Stromdichte in Widerstände). Georg J. Erlacher. A record of experiments for determining the rise in temperature and allowable current density in nickelin wires. Tables. 1600 w. Electrotech Zeitschr—May 8, 1902. No. 48211 B.

Electrometer.

The Use of the Electrometer for the Direct Measurement of the Energy, Current Strength and Phase Angle of Alternating Currents (Anwendung des Elektrometers bei Wechselstrom zur Direkten Messung des Effektes, des Stromes und des Phasenwinkels). Karl Hohage. A description of method with diagram of connections. 400 w. Electrotech Zeitschr—April 24, 1902. No. 48205 B.

Electro-Tellurograph.

Earth Currents and the Electro-Tellurograph. E. Guarini. Illustrated description of this apparatus for the study of earth currents. 800 w. Elec Rev. Lond—May 16, 1902. No. 48350 A.

Hot Wire Meters.

Hot-Wire Electric Meters (Ueber Hitzdrahtstrommesser). Prof. Kollert. The theory and design of electric meters which operate by the heating of wires by the electric current. Diagrams and formulæ. 1800 w. Elektrotceh Zeitschr—May 1, 1902. No. 48209 B.

Hysteresis.

The Ballistic Measurement of Hysteresis. G. F. C. Searle. A connected account of the principles involved in the ballistic method of hysteresis measurement, together with a description of the practical details of the method. 3600 w. Elect'n, Lond—May 9, 1902. Serial. 1st part. No. 48165 A.

Magnetic Testing.

A Null Method of Magnetic Measurements. Rudolf Goldsmidt. From the *Electrotechnische Zeitschrift*. Illustrated description of method determining the magnetic force of given windings which gives fairly accurate results. 900 w. Elect'n, Lond—May 2, 1902. No. 48080 A.

Industrial Tests of the Magnetic Properties of Iron (Rapport sur les Travaux de la Sixième Commission: Les Essais Magnetiques des Fers dans l'Industrie). M. Armagnat. A report of a committee of the Société Internationale des Slectriciens on the advisability of making magnetic tests in commercial and practical work, with list of questions sent to manufacturers. 1500 w. Bull Soc Internationale d Elect—March, 1902. No. 48402 E.

The Measurement of Magnetic Induction. C. W. Burrows. Experimental investigations with description and illustrations of instrument used. 1500 w. Horseless Age—May 21, 1902. No. 48-318.

Regulations.

Regulations for the Construction and Testing of Apparatus and Materials (Vorschriften für die Konstruktion und Prüfung von Installationsmaterial). Regulations and specifications for electrical apparatus and materials, proposed by a committee of the Verband Deutscher Elektrotechniker. 1500 w. Elektrotech Zeitschr—May 8, 1902. No. 48213 B.

Rheostat.

Determination of the Regulating Resistance of Self-Exciting Shunt Generators (Bestimmung der Stufen und Stufung des Regulirwiderstandes von Nebenschlussgeneratoren mit Selbsterregung). Rudolf Krause. An illustrated discussion of the design of rheostats for regulating dynamos. 800 w. Elektrotech Zeitschr—May 1, 1902. No. 48208 B.

Wattmeters.

The Measurement of Electrical Energy (Ueber Messungen Elektrischer Effekte). J. Görner. A discussion of the measurement of the energy of alternating and polyphase currents of various wave forms, and descriptions of wattmeters which fulfil all requirements. Diagrams and illustrations. Serial. 2 parts. 4500 w. Elektrotech Zeitschr—April 17, 24, 1902. No. 48201 each B.

POWER APPLICATIONS.

Electric Driving.

Electric Power Installations at the Ongrée Works, Belgium. Illustrates and describes the leading features of an installation for electric power and light in large mechanical works. 3200 w. Ir & Coal Trds Rev—May 16, 1902. No. 48370 A.

Power Generating Equipment of a Spice Factory. Illustrated detailed description of a plant at Charlestown, Mass. 1800 w. Am Elect'n—May, 1902. No. 47947.

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Power Plant of the Otis Elevator Co., Yonkers, N. Y. Arthur L. Rice. Illustrated detailed description. 2200 w. Engr, U S A—May 1, 1902. No. 47959.

Elevators.

The Electric Elevator. H. D. James. Illustrates and describes the mechanism and the operation. 3000 w. Am Elect'n—May, 1902. No. 47948.

Induction Motors.

An Important Polyphase Motor Decision. Judge Brown's decision in the suit of the Westinghouse Electric and Manufacturing Co. vs. the Royal Weaving Co. for infringement of the Tesla patents for polyphase motors. 2500 w. Elec Rev, N Y—May 24. 1902. No. 48337.

The Single-Phase Induction Motor. A. S. M'Allister. An outline of the characteristic features of the single-phase induction motor, showing the similarities and differences between the performance of a single-phase and a polyphase machine and investigating the methods by which the single-phase motor may be operated under various conditions. 2800 w. Am Elect'n—June, 1902. No. 48304.

Mill Driving.

Electricity in Cotton Mills. W. B. Smith Whaley. An account of the installation of an electric plant, tests, comparisons, etc. 2500 w. Trans Am Soc of Mech Engrs, No. 0942—May, 1902. No. 47980.

Motor Testing.

How to Test Electric Motors. A practical talk on methods of testing, explaining the principles upon which the test depends. 3000 w. Steam Engng—May 15, 1902. No. 48329.

Sewage Disposal.

Electro-Pneumatic Control of the Moon Island Sewage Reservoir. Gives a resume of the sewage systems of Boston with an illustrated description of the appliances now in use. 2500 w. Ry & Engng Rev—May 17, 1902. No. 48145.

Synchronous Motors.

Synchronous Motor Calculations. F. G. Baum. Gives a method for solving synchronous motor problems which is as simple as the solving of problems concerning a generator. 3200 w. Elec Wld & Engr—May 17, 1902. No. 48151.

Telpherage.

The Telpherage System of Electric Traction. Illustrates and describes this system for the transportation of material, and its applications and merits. 1000 w. Sci Am Sup—May 17, 1902. No. 48106.

Testing Tank.

The Electrical Equipment of the Experimental Model Basin at Washington Navy Yard. J. Adger McCrary. An illustrated detailed description of the machinery and apparatus employed, particularly the electrical devices used. 1500 w. Elec Wld & Engr—May 10, 1902. No. 48038.

Turntable.

An Electrically Operated Turntable (Ueber einen Neuen Elektrischen Antrieb von Drehscheiben). E. Block. An illustrated description of a Westinghouse electric motor which runs on the circular track under the table and pulls the latter around. 1200 w. Glasers Annalen—May 1, 1902. No. 48243 D.

MISCELLANY.

Düsseldorf Exposition.

See Industrial Economy.

Electric Accidents.

Electric Accidents and the Means of Preventing Them. L. W. de Grave. Abstract of a paper read before the Chesterfield and Midland Co.'s Inst. of Engrs. Considers accidents due to shock and to fire. 2000 w. Quarry—May 1, 1902. No. 48071 A.

Kelvin.

Lord Kelvin, His Work and Influence. F. B. Crocker. A comprehensive examination of the effect of the work of Lord Kelvin upon the development of electrical engineering. 2000 w. Engineering Magazine—June, 1902. No. 48391 B.

Magnetic Separator.

See Mining and Metallurgy, Iron and Steel.

Model Contracts.

The Institution and Its Proposed Model Contracts. Gives the more important of the draft clauses of the proposed form for use in connection with contracts for plant, mains, and apparatus for electricity works, with comments. 6000 w. Elect'n, Lond—April 25, 1902. No. 47880 A.

Report.

General Electric Report. Report for the year ending Jan. 31, 1902, containing much information of interest. 4000 w. Elec Wld & Engr—May 3, 1902. No. 47924.

Tariff.

The Influence of Tariffs on Electricity Supply. J. R. Dick. Critical reply to articles by C. Ashmore Baker on this subject. 1400 w. Elec Rev, Lond—April 25, 1902. No. 47875 A.

Winding.

Formers and Former-Winding. F. W. Davies. On the construction and use of formers, giving a general classification of the principal types, method of winding, etc. 2000 w. Elec Engr, Lond—May 9, 1902. Serial. 1st part. No. 48164 A.

We supply copies of these articles. See page 651.

GAS WORKS ENGINEERING

Address.

President's Address before the Institution of Gas Engineers in London. Thomas Holgate. Gives a sketch of ideal gas works, discussing details, and giving interesting statements in regard to incandescent lighting. Ill. 8700 w. Gas Wld—May 3, 1902. No. 48121 A.

Analysis.

The Analysis of Blast Furnace and Producer Gas (Analyse der Hochofen und Generatorgase). A. Wencelius. An illustrated account of apparatus, methods and results. 2000 w. Stahl u Eisen—May 1, 1902. No. 48251 D.

Carbonizing.

A Suggestion for Unification in the Methods of Stating the Items Comprising the Carbonizing Costs in Gasworks. W. R. Herring. Read before the Inst. of Gas Engrs. On the value of statistical research, and uniformity in reporting statements. 3500 w. Gas Wld—May 3, 1902. No. 48124 A.

Condensation.

Coal Gas Condensation: A Theory. A. F. Browne. Discusses the question of the position of the condenser with regard to the exhauster, the effect of expansion, etc. General discussion. 11300 w. Gas Wld—May 3, 1902. No. 48125 A.

Depreciation.

Depreciation in Gas Plants. R. W. Prosser. A discussion of this subject, and explanation of methods of calculating the yearly sum charged to depreciation in gas works. 2200 w. Am Gas Lgt Jour—May 26, 1902. No. 48328.

Distribution.

Distribution—Developments to Meet Rapidly Increasing Consumption. A. B. Walker. Read before the North of England Gas Mgrs. Assn. A record of developments carried out in the last six years. Also discussion. 5000 w. Jour Gas Lgt—April 29, 1902. No. 48074 A.

Explosions.

Gas Explosions in Electric Supply Conduits. This first article gives an account of a case in the English courts. 2000 w. Elec Rev, Lond—April 25, 1902. Serial. 1st part. No. 47876 A.

Future Gas.

The Illuminating Power of the Gas of the Future. Harry Edward Jones. Read before the Inst. of Gas Engrs. Discusses how an illuminating gas of 10 or 12 candles may best be produced, the subject of fuel gas for power, and other matters of related interest. General discussion. 11500 w. Gas Wld—May 3, 1902. No. 48123 A.

Gasholders.

A Talk on the Development of the Gasholder. George Livesey. Sketches the gradual growth in size and construction and gives interesting information. Ill. Discussion. 7200 w. Gas Wld—May 3, 1902. No. 48127 A.

Governors.

Governors on Service Pipes and Burners. Summary of a report by F. Pennertz, in the *Journal für Gasbeleuchtung*, of the results of a study made on the action of governors. 1200 w. Jour Gas Lgt—April 29,1902. No. 48077 A.

High Pressure.

The Cost of High-Pressure Gas-Lighting. Statement of J. G. Newbigging, giving details of expense connected with a Welsbach high-pressure installation for twelve months. 600 w. Jour Gas Lgt—April 29, 1902. No. 48078 A.

Incandescence.

Experience in Incandescent Gas Lighting at the Antipodes. An account of incandescent gas affairs in Australasia. 3300 w. Jour Gas Lgt—April 22, 1902. No. 47848 A.

Inverted Incandescent Gas Lamps. Illustrated description summarized from the *Journal für Gasbeleuchtung*. 1100 w. Gas Wld—May 3, 1902. No. 48120 A.

Oil Gas and Oil Incandescent Lighting. Slightly condensed lecture of Vivian B. Lewes, before the Petroleum Inst. Considers methods of production, cost, processes and results, mantles, lamps, etc. 7500 w. Jour Gas Lgt—April 22, 1902. No. 47849 A.

The Incandescent Mantle Trade. Concerning the agreements and negotiations concerning the Welsbach mantles, as settled in the British Law Courts. 2400 w. Gas Wld—April 26, 1902. No. 47872 A.

Mains.

The Relative Advantages of Cast Iron and Wrought Iron Gas Mains. Godfrey L. Cabot. Gives evidence in favor of wrought iron. 1600 w. Am Gas Lgt Jour—May 12, 1902. No. 48049.

Naphthalene.

The Solubility of Naphthaline. P. F. Smith. Read before the Inst. of Gas Engrs. Gives results of laboratory work in determining the value of various solvents when employed for clearing mains

We supply copies of these articles. See page 651.

and service pipes. Discussion. 3900 w. Gas Wld—May 3, 1902. No. 48126 A.

Producer.

Gas Producer with Suction Down Draft (Gazogène à Combustion Renversée par Aspiration). J. Deschamps. An illustrated description of a gas generator of the Loomis type, using all kinds of fuels rich in volatile products. 1800 w. Génie Civil —April 25, 1902. No. 48285 D.

Purifiers.

Construction of Purifiers. Ed. Jaeger. From *Journal für Gasbeleuchtung.* Illustrates and describes a construction that has been found very satisfactory. 1000 w. Gas Wld—May 10, 1902. No. 48163 A.

Subway.

A Short Account of the Construction of a Subway for a Gas-main Under Queen's Dock Basin, Hull, England. F. J. Bancroft. Read before the North of England Gas Mgrs. Assn. Ill. 1800 w. Jour Gas Lgt—April 29, 1902. No. 48075 A.

Tar and Ammonia.

Progress in the Production of Tar and Ammonia from the Gases of Blast Furnaces and Producers (Fortschritte in der Gewunnung von Theer und Ammoniak aus den Gasen der Hochöfen und Geratoren). A review of methods and results in gaining these by-products. 4500 w. Stahl u Eisen—May 1, 1902. No. 48252 D.

Wood Gas.

A New Riché Combustion Gas Generator (Nouveau Gazogène à Combustion de la Compagnie du Gaz Riché). G. Briand. An illustrated description of a gas generator using either wood or coal fuel, with table of tests. 800 w. Génie Civil—April 12, 1902. No. 48281 D.

On the Use of Wood Gas in the Manufacture of Iron and Steel. Dr. James Douglas. An illustrated article on the gasification of wood for gas engine purposes. 1800 w. Can Min Rev—April 30, 1902. No. 47004 B.

INDUSTRIAL ECONOMY

Competitions.

Principles for the Government of Competitions (Grundsätzen für Preisbewerbungen). A report of a committee of the Oesterr Ing. und Arch. Verein on the principles which should govern architectural and engineering competition. 5500 w. Supplement to Zeitscher d Oesterr Ing u Arch Ver—May 9, 1902. No. 48246 B.

Cost-Keeping.

Co-operation and Mechanical Aids to Work-Shop Cost-Keeping. R. P. Link. Read before the Northeast Coast Inst. of Engrs & Shipbuilders. Aims to show the superiority of the machine control system over the board system. 4000 w. Mech Engr—April 26, 1902. No. 47870 A.

Dusseldorf Exposition.

The Building of the Düsseldorf Exposition (Die Industrie und Gewerbeausstellung in Düsseldorf 1902. Bemerkenswerte Bauwerke). O. Leitholf. A well illustrated review of the principal buildings of this large German exposition and their details of construction. Serial. 1st part. 1 plate. 2500 w. Zeitschr d Ver Deutscher Ing—May 3, 1902. No. 48233 D.

The Düsseldorf Exposition of 1902 (Die Industrie-Gewerbe-und Kunstausstellung in Düsseldorf 1902). O. Liethölf. A general review of this industrial and art exposition of the Westphalian and Rhineland provinces, with illustrations and plans. 2500 w. Zeitschr d Ver Deutscher Ing—May 3, 1902. No. 48231 D.

The Düsseldorf Exposition (Die Industrie-,Gewerbe-und Kunstausstellung 1902 in Düsseldorf). A. Seyfferth. An illustrated review of this large German exposition, particularly of the electric and steam plants. Serial. 2 parts. 8000 w. Elektrotech Zeitschr—May 8 and 15, 1902. No. 48210 each B.

The Düsseldorf Exposition of 1902 (Die Düsseldorfer Ausstelling 1902). An illustrated general review of this large German exposition. Serial. 1st part. 1500 w. Glasers Annalen—May 1, 1902. No. 48242 D.

The Düsseldorf Exposition of 1902 (Exposition Industrielle de Düsseldorf en 1902). Alex. Gouvy. A general review of the exposition, with plan, and statistics of the Rhenish-Westphalian district and its industries, particularly coal and iron. 1 plate. 5000 w. Mem Soc Ing Civils de France—Feb., 1902. No. 48407 G.

The Rhenish-Westphalian Industrial Exposition (Rheinisch-Westfälische industrie Ansstellung). An illustrated general review of the engineering features of this large German exposition. 4000 w. Stahl u Eisen—May 1, 1902. No. 48274 D.

See also Mechanical Engineering; Mining and Metallurgy.

Economics.

The Study of Economics. Editorial

discussing the value of this study, its relation to the engineer, etc. 3000 w. Engng —May 9, 1902. No. 48183 A.

Engineering Societies.

The Engineering Societies of Great Britain and Germany (Développement des Associations d'Ingénieurs en Angleterre et en Allemagne). M. Alby. A review of the principal engineering associations of Great Britain and Germany, their organization, objects, numbers, property, work, etc., with diagrams. 8000 w. Bull Soc d'Encouragement—April, 1902. No. 48290 G.

Factory Office.

The Factory Office as a Productive Department. Kenneth Falconer. Mr. Falconer's third paper discusses the relations of the factory office to the stock room and shipping department. 3000 w. Engineering Magazine—June, 1902. No. 48396 B.

French Coal Miners.

Labor Conditions at the Coal Mines of Northern France (Arbeiterverhältnisse und Arbeiter-Wohlfahrtseinrichtungen im Steinkohlenbezirk der Departments Nord und Pas-de-Calais in Nordfrankreich). Hr. Tittler. A review of the coal miners' work, social conditions, benevolent associations, etc., and illustrations of workmen's dwellings. 1 plate. 5500 w. Glückauf—May 10, 1902. No. 48260 B.

Labor.

The Labor Question in Providence. Substance of the form of agreement presented by the employees for the acceptance of the United Traction & Electric Co., with the reply of the Company. 2000 w. St Ry Rev—May 20, 1902. No. 48341 C.

The Relative Position of Employer and Employed. Edward B. Gilmour. Arguments showing the interests are co-equal. 1100 w. Jour Am Found Assn—May, 1902. No. 47921.

Municipal Undertakings.

Municipal Socialism in Great Britain. Discussing the ownership and operation of certain undertakings and enterprises by the municipality, supposedly for the public good, and the increasing development of such enterprises in Great Britain. 4200 w. U. S. Cons Repts, No. 1345—May 19, 1902. No. 48136 D.

Profit-Sharing

A Dividend to Labor. J. Holliday. Read before the North of England Gas Mgrs. Assn. A few ideas on the subject of profit-sharing as related particularly to gas undertakings. 2500 w. Jour Gas Lgt —April 29, 1902. No. 48076 A.

Shipping Combination.

The American Shipping Combine. Editorial discussion of the proposed arrangement for the control of the Atlantic shipping trade. 3500 w. Engng—May 2, 1902. No. 48065 A.

The Atlantic Shipping Combination. Editorial discussion of the schemes of J. Pierpont Morgan in this field. 1200 w. Engr, Lond—May 2, 1902. No. 48058 A.

The Shipping Combine. Editorial discussion of the recent arrangements under the leadership of Mr. J. P. Morgan, and the effect on British trade. 3000 w. Engng —May 16, 1902. No. 48363 A.

United States.

Some Great Things Which Make Our Country Great. John Birkinbine. Reviews the resources of the country, the industries, engineering works and wealth, in a general way. 2400 w. Pro Engrs Club of Phila—April, 1902. No. 47842 D.

Works Management.

Money-Making Management for Workshop and Factory. C. U. Carpenter. Mr. Carpenter"s fifth paper discusses the operation of a complete system of stock tracing, and inspection. 5000 w. Engineering Magazine—June, 1902. No. 48398 B.

MARINE AND NAVAL ENGINEERING

Armament.

The Admiralty Policy as to Armament. Editorial discussing the need of rearmament of the British fleet. 1500 w. Engng—May 16, 1902. No. 48364 A.

Barkentine.

The Steam Barkentine Gauss of the German Antartic Expedition. George Crouse Cook. Illustrated description of this vessel for special service built at Kiel, Germany. 1300 w. Marine Engng—May, 1902. No. 47930 C.

Battleship.

The New French Battleship Suffren. Illustrations with description. 1000 w. Engr, Lond—May 9, 1902. No. 48187 A.

Boats.

Boats and Boat Building in the Malay Peninsula. H. Warington Smythe. An illustrated article describing the types of boats and the conditions they were to meet, methods of building, etc., with list of boats and tabulated information. Also discussion. 9600 w. Jour Soc of Arts—May 16, 1902. No. 48342 A.

Conveying.

Handling Material in Shipyards. Waldon Fawcett. Some of the recent devices for expeditiously and economically handling heavy material are illustrated and described. 1200 w. Sci Am—May 24, 1902. No. 48300.

We supply copies of these articles. See page 651.

Economy.

The Growth of Economy in Marine Engineering. W. M. McFarland. Mr. McFarland's concluding paper discusses the improvements which have particularly affected the performance of naval engines. 5000 w. Engineering Magazine—June, 1902. No. 48397 B.

Explosion.

The Explosion of H. M. S. "Mars." A statement of the facts so far as known, and explanation of the cause. 1400 w. Engng—April 25, 1902. No. 47884 A.

Liner.

New Orient Liner Orontes. Describes a new twin-screw steamer intended for the Australian trade. Ill. 1000 w. Engr, Lond—May 16, 1902. No. 48369 A.

Motor Launches.

Motive Powers for the Modern Launch. E. W. Roberts. A fully illustrated study of the marine applications of electrical, gasoline, and oil motors, especially for the propulsion of launches and small boats. 5000 w. Engineering Magazine—June, 1902. No. 48392 B.

Refrigeration.

Refrigeration on Shipboard. E. N. Percy. The first of a series of articles written to urge the use of a higher standard of refrigerating machinery for marine service, its inspection, etc. 1800 w. Ill. Marine Engng—May, 1902. Serial. 1st part. No. 47929E C.

Ship Resistance.

The Resistance Due to Accompanying Waves (Résistance Due aux Vagues Satellites). M. de Bussy. A mathematical discussion of ship resistance due to the accompanying waves. 1500 w. Comptes Rendus—April 14, 1902. No. 48424 D.

Ship Yards.

Organization of Ship Yards. Theodore Lucas. Considers points relating to the organization to adapt it to its natural run of business. 2000 w. Naut Gaz—May 8, 1902. No. 48031.

Steamships.

Pacific Mail Steamships Korea and Siberia, built by the Newport News Shipbuilding and Dry Dock Co. Illustrated detailed description of the largest ships yet built in America. 4800 w. Marine Engng—May, 1902. No. 47928 C.

The Growth of the Trans-Atlantic Steamship. Interesting diagrams, with notes on the development. 2000 w. Sci Am—May 3, 1902. No. 47853.

Testing Tank.

See Electrical Engineering, Power Applications.

Warships.

Warships (La Marine Militaire). Hector Pouleur. An illustrated general review of naval architecture, warship construction and armament, types of warships, and also brief account of latest ocean liners. 2 plates. 14000 w. Rev Univ d Mines—Feb., 1902. No. 48415 H.

Wrecking.

The Salving and Floating of Wrecked Vessels (Sauvetages et Renflouages des Navires Neufragés). M. Dibos. A general review of methods of wrecking and raising sunken boats and ships. 10000 w. Mem Soc Ing Civils de France—March, 1902. No. 48411 G.

MECHANICAL ENGINEERING

AUTOMOBILES.

Accumulators.

Some Modern Automobile Accumulators. Illustrations and descriptions of typical battery cells used in the electric vehicles at the present time. 1500 w. Sci Am—May 17, 1902. No. 48101.

Automobiles.

Automobiles. Hiram Percy Maxim. Discusses four classes of city transportation where motor vehicles should prove more satisfactory than the horse. Also general discussion. 12400 w. Ill. Pro Engrs' Soc of W Penn—April, 1902. No. 47890 D.

Condensers.

Steam Condensers. Arthur L. Stevens. Considers the application to automobiles, the advantages and disadvantages. 1000 w. Horseless Age—May 14, 1902. No. 48091.

Daimler Motor.

King Edward's Daimler. A. F. Sinclair. A brief account of Coventry, England, with history of the Daimler Company, and illustrated descriptions of cars made for King Edward VII. 4000 w. Auto Mag—May, 1902. No. 47829 C.

Endurance Run.

Long Island's Century. Francis P. Prial. An illustrated account. 1700 w. Auto Mag—June, 1902. No. 48354 C.

Long Island Endurance Contest. An illustrated report of the contest, the vehicles entered and their performance, etc. 22500 w. Horseless Age—April 30, 1902. No. 47946.

The Long Island Contest from the Standpoint of a Steam Carriage User.

Ernest Duval. Remarks on the contest and vehicles tested. 1500 w. Horseless Age—May 7, 1902. No. 48017.

Exhibitions.

Lamps, Burners and Heating Apparatus at the Paris Alcohol Exposition. Illustrated description of exhibits. 3200 w. Sci Am Sup—May 17, 1902. No. 48104.

Motor Car Exhibition at Islington. Report of a very successful exhibition, with illustrated descriptions of exhibits. 3500 w. Engr, Lond—April 25, 1902. Serial. 1st part. No. 47887 A.

The Motor-Car Exhibition. A brief account of some of the exhibits at Islington, England, where an exhibition has recently been held. Also editorial. 5200 w. Engng—April 25, 1902. No. 47883 A.

Ignition.

Early Electric Ignition. Douglas Leechman. Gives brief extracts from early patents showing electric ignition for internal combustion motors to be nearly fifty years old. 1000 w. Autocar—April 26, 1902. No. 47867 A.

Lurry.

A. Napier Lurry. Illustrates and describes the construction of a patrol lurry. 1800 w. Auto Jour—May 17, 1902. No. 48347 A.

Mechanical Traction.

Mechanical Road Traction. A. E. A. Edwards. Abstract of a paper read before the Birmingham Assn. of Mech. Engrs. Briefly reviews the history and considers present problems under heads of (1) Resistances to motion; (2) motive power; (3) cost of running; (4) future developments. 3700 w. Mech Engr—May 3, 1902. No. 48069 A.

Motor Car.

The 40 H. P. Mercedes-Simplex. An illustrated description of the general arrangement of the car, mentioning the special features. 2000 w. Autocar—May 10, 1902. Serial. 1st part. No. 48161 A.

The Gillet-Forest Car. An illustrated description of one of the most interesting of recent French cars. The framework is built entirely of tubes. 2000 w. Auto Jour—May 10, 1902. No. 48162 A.

Motor Car Trials.

Industrial Motor Car Trials in France. Begins a report of the trial from Paris to Monte Carlo, a distance of about 700 miles to be covered in 11 days. Illustrates and describes the vehicles entered and reports their performance. 2200 w. Engr, Lond—May 2, 1902. Serial. 1st part. No. 48055 A.

Speed.

How to Estimate the Speed of an Automobile. A. L. Clough. Gives a table corresponding to the time required to cover a mile, and considers methods of determining speed. 800 w. Horseless Age—May 7, 1902. No. 48018.

Stability.

The Conditions of Stability for Automobiles on Curves (Sur les Conditions de Stabilité des Automobiles dans les Courbes). A. Petot. A mathematical discussion, with suggestions of causes of accidents to automobiles on curves. 600 w. Comptes Rendus—April 7, 1902. No. 48422 D.

Steam Carriage.

The First Road Engine. Angus Sinclair. Illustrated description of Cugnot's engine built in the 18th century. 800 w. Auto Mag—June, 1902. No. 48355 C.

The Hyler White Carriage. J. S. V. Bickford. General high praise of the design with criticism of a few details. 1600 w. Horseless Age—May 14, 1902. No. 48089.

Steering.

Improved Link Details of Locked Wheel Steering Devices. Hugh D. Meier. Illustrates and describes several devices that embody resilient members, discussing their advantages. 1000 w. Horseless Age—May 14, 1902. No. 48090.

Tests.

A. C. A.'s Official Stopping Tests. An illustrated account of tests made on Riverside Drive, New York, by the Automobile Club of America. 2500 w. Auto Topics—May 10, 1902. No. 47992.

Trial Runs.

Paris to Monte Carlo. An illustrated account of this 700 miles run, giving the performances of the industrial motor vehicles. 2200 w. Autocar—May 3, 1902. Serial. 1st part. No. 48072 A.

The Glasgow to London Non-Stop Trial. An account of the run, with some amusing incidents included. 3500 w. Auto Jour—April 26, 1902. No. 47869 A.

Trials.

Hill-Climbing and Consumption Trials. An illustrated account of the Automobile Club tests on the London-Oxford road and the scalings of Dashwood Hill, giving descriptions of vehicles. 4500 w. Autocar—May 17, 1902. No. 48344 A.

The Automobile Consumption and Hill Climbing Trials. An illustrated account of the performance of the vehicles, with tabulated results. 2400 w. Auto Jour—May 17, 1902. No. 48345 A.

Wolseley Works.

The Wolseley Works and Cars. An illustrated description of works for motor carriage building and some of the latest types of vehicles. 3500 w. Auto Jour—May 17, 1902. Serial. 1st part. No. 48346 A.

We supply copies of these articles. See page 651.

HYDRAULICS.

Centrifugal Pumps.

The Schabaver Centrifugal Pump (Pompe Centrifuge Schabaver). Gérard Lavergne. An illustrated description of pumps for lifting water to great heights, with account of tests. 2400 w. Génie Civil —April 19, 1902. No. 48283 D.

Plumbing.

Details of New York School Plumbing. Illustrated description of standard details for shower baths, drinking fountains, drains and laboratory fittings. 2300 w. Eng. Rec—May 3, 1902. No. 47862.

Pumping Engine.

A New High-Duty Pumping Engine of the Compensating Type. Illustrated description of a pumping engine in which the end stroke of one piston rod is reinforced from the other rod by means of a connecting link. 1100 w. Eng Rec—May 10, 1902. No. 47999.

Pumps.

Hydraulically Balanced Ashley Pump. Illustrated description of a new system of hydraulically balancing the load on the engine with the result that however the water level in the well may vary, the engine does exactly the same amount of work on successive up and down strokes. 2000 w. Engng—May 16, 1902. No. 48362 A.

Pump Valves.

Tests of the Relative Efficiency of Mechanically Operated and Automatic Spring Valves for Pumps (Versuche zur Ermittlung der Bawegungen und Widerstandsunterschiede Grosser Gestewerter und Selbstthätiger Federbelasteter Pumpen—Ringventile). Rud. Schröder. An exhaustive series of tests, showing the advantages of mechanically-operated pump-valves, of the Riedler type, with illustrations and many diagrams. 5 plates. 5000 w. Zeitschr d Ver Deutscher Ing—May 10, 1902. No. 48238 D.

Rams.

The Determination of the Efficiency of Hydraulic Rams. A. J. Wood, with discussion. A condensed study of the subject with discussions by William Kent, and by Prof. Theo. Woolsey Johnson. Ill. 6400 w. Stevens Ind—April, 1902. No. 47840 D.

MACHINE WORKS AND FOUNDRIES.

Annealing.

The Effect of Annealing Shot or Chilled Iron in the Determination of Phosphorus by the Permanganate Alkali Method. Charles E. Manby. Gives the method of analysis in detail. 1200 w. Pro Engrs' Soc of W Penn—April, 1902. No. 47891 D.

Boring.

Deep Hole Drilling in Gun Construction. J. M. B. Scheele. Describes the general features, giving sketches and engravings of the boring, turning and reaming operations on a 16-inch breech loading rifle built in the shops of the Government Army Gun Factory at Watervliet Arsenal, N. Y. 2200 w. Mach, N Y—May, 1902. No. 47909.

Chains.

The Spuhl New Chain Making Machine. Illustrated description of a machine, which will bend and weld effectively with report of tests as to the tensile strength of chains made. 1200 w. Ir Age—May 22, 1902. No. 48195.

Cranes.

See Electrical Engineering, Power Applications.

Cylinders.

Repairing a Broken Cylinder. H. M. Lane. An illustrated description of the work. 1000 w. Trans Am Soc of Mech Engrs, No. 0940—May, 1902. No. 47979.

Dies.

Artistic Die-Making. Joseph V. Woodworth. Illustrates and describes dies made in a small Brooklyn shop, and shows examples of work. 1200 w. Am Mach—May 15, 1902. No. 48094.

Cold Working Sheet Metal in Dies. John D. Riggs. Dies operated by presses are described and information concerning their use and economy given. Ill. 3000 w. Trans Am Soc of Mech Engrs, No. 0939—May, 1902. No. 47978.

Gain by Changing a Punching and Forming Operation. William H. Brooks. Illustrates a case of sheet metal stamping and the economy realized by a change in the method of production. 800 w. Am Mach—May 15, 1902. No. 48096.

Dividing.

A Scheme for Making the Universal Dividing Head Universal. W. A. Warman. Sketches and description of a device that gives accuracy. 600 w. Am Mach —May 15, 1902. No. 48095.

Engine Works.

Messrs. David Rowan and Co.'s Works, Glasgow. An illustrated detailed description of these fine works, with discussion of the engineering economy in the management of such works. 5400 w. Engng—May 9, 1902. No. 48179 A.

Grinding.

A Novel Tool-Grinding Attachment. Illustrates and describes a tool-grinding attachment designed by Prof. C. V. Boys for accurately grinding lathe and planing tools. 1000 w. Sci Am—May 24, 1902. No. 48198.

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Heating.

Hot-Water Heating in a Hartford Residence. Illustrated description of the low-pressure gravity hot-water system in a 3-story, 72x48 ft. house, explaining some methods of calculating the sizes of different parts of the plant. 1200 w. Eng Rec—May 24, 1902. No. 48194.

Lathe.

Ring Turret Lathe. Illustrated description of a turret lathe having a number of novel features, the most interesting one being the turret which is made in the form of a ring and encircles the bed. 1500 w. Am Mach—May 22, 1902. No. 48197.

Mixing Iron.

Economy of Mixing Iron by Chemical Process and Removal of Barriers to Its Adoption. Thomas D. West. Discusses the benefits of mixing by chemical analysis and movement to decrease the cost. 1400 w. Foundry—May, 1902. No. 47838.

Pattern Work.

Stopping Off and Saving Pattern Work. John M. Richardson. Illustrates and describes cases where great expense is saved by this process. 1000 w. Am Mach—May 1, 1902. No. 47935.

Planing.

Circular Planing Attachment. Illustrated descrintion showing how the steam chest of a laundry mangle was machined to fit the ironing roller. 600 w. Am Mach—May 22, 1902. No. 48196.

Records.

Workshop Records in Cards and Files. George Parker. Read before the North-east Coast Inst. of Engrs. & Shipbuilders (Great Britain). Describes applications of cards for various purposes, and gives the origin of the system. 7700 w. Ir Trd Rev—May 1, 1902. No. 47926.

Screw-Threads.

A Proposed Standard for Machine Screw Thread Sizes. Charles C. Tyler. Attention is called to the inconvenience resulting from the variation in size and a standard is proposed having an angle of 60 degrees and a flat at the top of the thread equal to ⅛ of the pitch. Ill. 3500 w. Trans Am Soc of Mech Engrs, No. 0931—May, 1902. No. 47970 C.

Shear.

The Flying Shear. V. E. Edwards. Photographs and sectional drawings of the different styles of shears are given with description of operation and work accomplished. 1600 w. Trans Am Soc of Mech Engrs, No. 0936—May, 1902. No. 47975.

Shop Methods.

The National Cash Register Co., of Dayton, O., and Its Manufacturing and Cost-Keeping Methods. An illustrated article explaining the system adopted and its success. 8500 w. Ir Trd Rev—May 1, 1902. No. 47927.

Specifications.

Specifications for Steel Forgings, Steel Castings and Steel Boiler Plates. William K. Webster. The standard specifications of the American section of the International Assn. for Testing Materials are presented for discussion. 2500 w. Trans Am Soc of Mech Engrs, No. 0948—May, 1902. No. 47986.

Springs.

Construction of Elliptical Springs. Charles A. Lindstrom. Calls attention to the methods that should be followed in the calculations of elliptical and semi-elliptical springs so as to guard against an excessive deflection. Also discussion. Ill. 7600 w. Pro W Ry Club—April 18, 1902. No. 47-944 C.

Hardening and Tempering Coil Springs. E. R. Markham. Suggestions helpful in securing success. 1300 w. Mach, N Y—May, 1902. No. 47910.

Tool Steel.

Points of Heat Treatment of Tool Steel. C. P. Crowe in the *American Blacksmith*. Gives suggestions and tables to serve as guides in hardening and tempering. 2000 w. Ir Trd Rev—May 8, 1902. No. 48032.

Wire.

The Diamond in Wire Drawing. S. Barnett. Information of interest concerning the selection of the stones and the drawing of copper and steel wire. 3200 w. Ir Age—May 29, 1902. No. 48376.

MATERIALS OF CONSTRUCTION.

Alloys.

A Useful Alloy of Copper, Zinc and Aluminum for Sand Casting. Erwin S. Sperry, in *Aluminum World*. Describes an alloy known as "aluminum silver," noting the characteristics, good qualities, uses, etc. 3000 w. Foundry—May, 1902. No. 47837.

Corrugated Metal.

The Moments of Inertia and of Resistance of Corrugated Sheet Metal (Zur Berechnung der Trägheits und Widerstandsmomente von Wellblechen). Leopold Pfeffer. Article with diagrams and tables founded on formulæ due to the late Prof. R. F. Mayer, of Vienna. 1500 w. Oesterr Wochenschr f d Oeffent Baudienst—April 12, 1902. No. 48215 B.

Leather.

Tests of Leather (Essais du Cuir dans ses Applications Industrielles). Henri Boulanger. A well illustrated account of an extensive series of tensile tests of leather prepared in various ways for industrial

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purposes, with tables and diagrams. Serial. 1st part. 9000 w. Bull Soc d'Encouragement—April, 1902. No. 48291 G.

MEASUREMENT.

Drafting.

Proportions and Spacing of Roman Letters. William Welch. An analysis of a number of the best Roman alphabets and their spacing, with rules for laying off such lettering. 3000 w. Eng Rec—May 17, 1902. No. 48133.

Extensometer.

A Roller Extensometer. Gus C. Henning. Describes the new type of instrument and its working. Ill. 2200 w. Trans Am Soc of Mech Engrs, No. 0945—May, 1902. No. 47983.

Metric System.

The National Bureau of Standards. S. W. Stratton. Shows the condition of affairs that led the U. S. Congress to establish the National Bureau of Standards, describing the work belonging to it, and showing the need of the adoption of uniform and correct standards, especially between nations, and urging the adoption of the metric system. Also discussion. 7700 w. Pro Engrs Club of Phila—April, 1902. No. 47843 D.

POWER AND TRANSMISSION.

Belting.

Belting for Power Transmission (Organes de la Transmission: Notes sur la Courroie). L. Tourneux. A discussion of belts and belting for the transmission of motion and power, with table of best speeds and horse-power. 2500 w. Revue Technique—May 10, 1902. No. 48401 D.

Chain Gear.

The Renold Silent Chain Gear. J. O. Nixon. An illustrated detailed discussion of a gear that may be run at high speeds, with no noise, for the transmission of any amount of power. 3500 w. Jour Fr Inst—May, 1902. No. 47994 D.

Compressed Air.

A New Means of Using Compressed Air in the Manufacture of Glassware. Illustrated description of a process invented by Paul T. Sievert, which bids fair to overcome the difficulties which have hitherto baffled the glass manufacturers. 1500 w. Sci Am—May 10, 1902. No. 48028.

Compressed Air. W. L. Saunders. Discusses the subject of compression, cooling, oil, etc., and concludes with a number of "Dont's," bearing on this subject. 3000 w. Can Min Rev—April 30, 1902. No. 47903 B.

Conveyor.

A Cableway for Conveying Waste Material to the Dump Pile (Ueber die Aufstellung eines Seilbahnkrahnes zum Transporte des Tauben Materiales auf die Holde). Hans Haberfelner. An illustrated description of a Brown conveying plant at the surface of a brown coal mine at Fohnsdorf, Austria. 1 plate. 4000 w. Oesterr Zeitschr f Berg u Hüttenwesen—May 3, 1902. No. 48267 B.

Cranes.

New Cranes in German Dockyards. Illustrates and describes recent equipments of these yards for handling large and heavy weights. 1300 w. Engr, Lond—April 25, 1902. No. 47888 A.

Crank.

A Three Headed, or Triangular Crank (Biellé à Trois Têtes on Bielles Triangulaires). M. Chaud. An illustrated description of transmitting mechanism in which, besides the cranks on the two working shafts, there is a crank on an idle shaft, the three being connected by a three-armed rigid piece. 600 w. Revue Technique—April 25, 1902. No. 48298 D.

Elevators.

Elevator Safeties. Charles R. Pratt. The defects of old-style safety devices are pointed out, and a new type is described. Ill. 2000 w. Trans Am Soc of Mech Engrs, No. 0946—May, 1902. No. 47984.

Industrial Plant.

The Oxford Paper Mills. Illustrated description of a mill for manufacturing daily 225 tons of soda and sulphite fiber and 200 tons of paper. The hydraulic and steam power plants are described, the various processes of making pulp and paper are explained, and the plant for the purpose is illustrated. 5900 w. Eng Rec—May 3, 1902. No. 47857.

Mechanical Power.

Shop Transportation. Cloyd Marshall. Illustrates and describes some mechanical appliances for the transportation of heavy materials. 2000 w. Engr, U S A—May 15, 1902. No. 48153.

Power Plant.

The Billancourt Compressed Air Plant, Paris. Illustrated description of plant of 7000 H. P. for furnishing compressed air at 1,140 lbs. for the use of cars operated by compressed air. 1400 w. Eng Rec—May 3, 1902. No. 47858.

Worm Gear.

Globoid Worm Gear (Globoid-schnecken). Prof. Georg Lindner. A well illustrated description of the globoid (or Hindley) worm gears, as modified by Lorenz, of Ettlingen, Baden, with account of tests. 2000 w. Zeitschr d Ver Deutscher Ing—May 3, 1902. No. 48235 D.

SPECIAL MOTORS.

Blast Furnace Gas.

Blast Furnace Gas and the Thwaite-

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Gardner Blowing Engine (L'Utilisation des Gaz de Hauts Fournaux. Machine Soufflante Thwaite-Gardner). Jules Deschamps. A discussion of the utilization of blast-furnace gas, and an illustrated description of the Thwaite-Gardner blowing engine of the Otto type. 2500 w. Rev de Mecanique—April, 1902. No. 48294 E+F.

Engines.

Steam, Gas and Oil Engines: Cost of Fuel per Brake Horse-Power per Hour and Their Heat Efficiencies. Bryan Donkin. Paper prepared for meeting of Inst. of Gas Engrs. Discusses the fuel required to produce power by means of these various engines. 2200 w. Gas Wld—May 3, 1902. No. 48122 A.

Exhaust Gases.

A Method of Determining the Temperature of Exhaust Gases in Combustion Engines. H. Fernald. Describes the forms of exhaust chamber which were tried, and a record of the experiments made is given. Ill. 3200 w. Trans Am Soc of Mech Engrs. No. 0932—May, 1902. No. 47971 C.

Gas Engines.

The Heat Balance of Gas Engines (Beitrag zur Wärmebilanz des Gasmotors). A. Staus. A discussion of the balance of the energy input and output of gas engines, with an illustrated description of a calorimeter for measuring the energy in the exhaust gas due to its heat and velocity of efflux. 1000 w. Zeitschr d Ver Deutscher Ing—May 3, 1902. No. 48236 D.

Working Details of a Gas Engine Test. R. H. Fernald. A complete system for testing gas engines is given, with the details of taking observations, making records and working up results, together with a blank for the recording of data and the complete log of two tests made. 14500 w. Trans Am Soc of Mech Mgrs, No. 0933—May, 1902. No. 47972 D.

Ignition.

Ignition and Ignition Gears for Internal Combustion Engines. Holberry Mensforth. Lecture delivered before the Sheffield Soc. of Engrs. and Metallurgists. A review of ignition gears up to the present, and a discussion of points showing the effects of a variation in the time and point of ignition. 5000 w. Mech Engr—May 10, 1902. No. 48154 A.

The Sparking Coil. E. J. Stoddard. Considers the working of ordinary coils, and gives facts obtained from experiments and actual trials. 3000 w. Horseless Age —May 21, 1902. No. 48317.

Internal Combustion Engines.

The Calculation of the Principal Dimensions of the Internal Combustion Engines (Berechnung der Hauptmasse der Verbrennungsmotoren). Hugo Güldner. An article on the design of these engines, with formulæ for the stroke, piston diameter, and number of revolutions, and also table of fuel data. 3000 w. Zeitschr d Ver Deutscher Ing—April 26, 1902. No. 48230 D.

STEAM ENGINEERING.

Balanced Engine.

The Wizzell Balanced Engine. R. J. Isaacson. Illustrated description with statement of advantages claimed. 2300 w. Mech Engr—April 26, 1902. No. 47871 A.

Blowing Engine.

See Mining and Metallurgy, Iron and Steel.

Boilers.

Another Scamped Boiler Job. An illustrated article discussing errors of construction. 1700 w. Locomotive—March, 1902. No. 48082.

Economy in Boiler Room. Paul McIntire. Briefly considers the conditions regulating boiler capacity, relation of grate surface to various fuels, scale and unclean boilers, etc. 1500 w. Ice & Refrig—May, 1902. No. 47896 C.

Leaky Boilers. Editorial discussion of the sources of weakness that cause these leaks. 1000 w. Loc Engng—May, 1902. No. 47961 C.

Boiler Cleaners.

Methods and Apparatus for Cleaning Boiler Tubes (Procédés et Appareils de Nettoyage des Chaudières Tubulaires). Illustrated description of all kinds of brushes and scrapers for cleaning the inside and outside of boiler tubes. 3500 w. Rev de Mecanique—April, 1902. No. 48293 E+F.

Objections to Water-Tube Boilers. W. H. Wakeman. Gives reasons for disapproving of this type of generator. 1700 w. Elec. N Y—May 14, 1902. No. 48030.

The Construction and Inspection of Steam Boilers; with Especial Reference to the "City of Trenton" Disaster. Discussion with illustrations. 5700 w. Jour Fr Inst—May, 1902. Serial. 1st part. No. 47993 D.

Boiler Trials.

Comparative Boiler Trials in Italy. Concerning the experiments recently made by the Italian Government on three large and precisely similar warships to determine the relative values of boilers of different types. Ill. 3000 w. Engng—May 16, 1902. No. 48359 A.

Condensing.

Condensing vs. Non-Condensing. Charles L. Hubbard. A discussion of this subject showing that the value of a condenser depends entirely upon existing conditions, and to a great extent upon the relative cost of water and coal. 2000 w. Am Elect'n—June, 1902. No. 48310.

Steam Condensers. Charles L. Hub-

bard. Presents the fundamental principles upon which a condenser operates, and gives descriptions of some of the standard types in use. Ill. 2000 w. Am Elect'n —May, 1902. No. 47949.

Dusseldorf Exposition.

Steam Engines at the Düsseldorf Exposition (Die Industrie und Gewerbeausstellung in Düsseldorf 1902. Die Dampfmaschinen). H. Dubbel. A well illustrated and comprehensive review of the steam engines exhibited at this large German exposition. Serial. Part 1. 1 plate. 3000 w. Zeitschr d Ver Deutscher Ing—May 3, 1902. No. 48232 D.

The Boilers at the Düsseldorf Exposition of 1902 (Die Industrie und Gewerbeausstellung in Düsseldorf 1902. Die Dampfkessel). H. Dubbel. A well illustrated, comprehensive review of the boilers and accessories exhibited at this large German exposition. Serial. 1st part. 4000 w. Zeitschr d Ver Deutscher Ing—May 3, 1902. No. 48234 D.

Engines.

An American Poppet-Valve Engine. Illustrated description of an engine of special interest from the fact that it is practically the first designed and built in the United States for electric station work with poppet valves. 4000 w. Power—May, 1902. No. 47931 C.

Final Report of the Committee Appointed to Standardize a System of Testing Steam Engines. The final revision of the report made after embodying the discussions. 25000 w. Trans Am Soc of Mech Engrs, No. 0943—May, 1902. No. 47981 D.

500 Horse-Power Tandem Engine and Alternator. An illustrated description of an exhibit at the Düsseldorf Exhibition 600 w. Engng—May 16, 1902. No. 48360 A.

Rolling Mill Engine. Illustrates and describes the compound engines at the Wardsend Steel Works, Sheffield, Eng. Ropes are used for driving, one of the drives having extraordinary length, but giving satisfactory results. 600 w. Engr, Lond—May 2, 1902. No. 48059 A.

The Tosi Engines. Illustrated description of horizontal tandem engines made in Italy for the Milan-Verese Electric Railway. 1000 w. Elec Engr, Lond—April 25, 1902. No. 47878 A.

Vertical Compound Engine for Cape Town. Illustrated description of Ferranti engine for the new supply station, calling attention to interesting features. 1800 w. Engr, Lond—May 9, 1902. No. 48186 A.

Hoisting Engines.

See Mining and Metallurgy, Mining.

Horse-Power.

A Horse-Power Chart. A. G. Holman. Gives chart and explanation of its use. 1000 w. Power—May, 1902. No. 47932 C.

Indicator.

The Rosenkranz Indicator with Cold Spring (Ueber einen Neuen Indikator mit Kaltfeder). An illustrated description of an indicator with an uncovered spring, which thus keeps cool and retains its accuracy. With diagrams of tests. 1 plate. 400 w. Glückauf—April 19, 1902. No. 48256 B.

Indicator Cock.

Improved Indicator Cock for Engines. Albert K. Mansfield. Illustrated description of a four-way cock to allow of taking a card from the steam chest or exhaust pipe in order to determine whether the piping between boiler and engine, or between engine and exhaust opening has been properly installed. 700 w. Trans Am Soc of Mech Engrs, No. 0938—May, 1902. No. 47977.

Joints.

A Swivelling Joint for a Sixteen-Inch High Pressure Steam Main. R. E. Curtis. The swivel joints described are used to connect two 16-inch steam mains, at points where the expansion is such as to make some flexible arrangement imperative. Ill. 600 w. Trans Am Soc of Mech Engrs, No. 0937—May, 1902. No. 47976.

Liquid Fuel.

Fuel Oil. W. W. Reed. Read at meeting of the Southwestern Gas, Electric and Street Railway Assn. Discusses the commercial side of the question, and the utilization of oil as fuel for steam purposes. 2600 w. Am Gas Lgt Jour—May 12, 1902. No. 48052.

Liquid Fuel Combustion. Charles E. Lucke. The difficulties are described and methods classified. An illustrated account is given of a series of experiments which were carried on to find a satisfactory burner, and the burner which proved successful. 8700 w. Trans Am Soc of Mech Engrs, No. 0934—May, 1902. No. 47973 C.

Liquid Fuel—Its Application, Past and Present. R. G. Paddock. Considers methods of application, devices used, experimental tests, etc. 7500 w. Jour Assn of Engng Soc's—April, 1902. No. 48087 C.

See also Railway Engineering, Motive Power and Equipment.

Pipe Coverings.

Tests of Steam Pipe Coverings. George H. Barrus. An account of tests made on a large scale and in most careful manner, with conclusions. Ill. 12600 w. Trans Am Soc of Mech Engrs, No. 0952—May, 1902. No. 47989 D.

The Loss of Heat from Covered Steam Pipes. Charles P. Paulding. Considers the tests of Peclet, Barrus and others, analyzing the results and giving applica-

tions of the theory. 5000 w. Stevens Ind —April, 1902. No. 47839 D.

Piping.

A Comparison of the Steam Piping Systems of the Four Large Electrical Stations of New York. C. G. Robbins. Presents, in a manner for easy comparison, the steam plants of the N. Y. Edison Co. (Waterside), the Manhattan El. Ry. Co., the Third Ave. St. Ry. Co., and the Metropolitan St. Ry. Co. Ill. 3700 w. Am Elect'n—June, 1902. No. 48306.

Steam Fitting. Warren E. Willis. Notes and suggestions upon erecting piping. 1800 w. Mach, N Y—May, 1902. No. 47912.

Pistons.

A Graphical Determination of Piston Acceleration. J. N. Le Conte. Presents a method for finding the acceleration of the cross-head for any given angular position of the crank. 1000 w. Trans Am Soc of Mech Engrs, No. 0953—May, 1902. No. 47990.

The Strength of Pistons of Steam Engines (Contribution à l'Etude de la Resistance des Pistons des Machines à Vapeur). Hector Pouleur. A mathematical discussion of the forces acting on pistons and their resistance. 7000 w. Rev Univ d Mines—April, 1902. No. 48421 H.

Speed Regulation.

Speed Regulators for Steam Engines (Etude des Regulateurs de Vitesse des Moteurs à Vapeur). The program of a section of the Société Internationale des Electriciens, a paper by C. F. Guilbert, on driving alternators in parallel, and notes by various other members. Diagrams. 13000 w. Bull Soc Internationale d Electriciens—April, 1902. No. 48406 E.

Steam Turbines.

The Coming of the Steam Turbine. Editorial reviewing the development. 1400 w. Loc Engng—May, 1902. No. 47962 C.

The Steam Turbine Generator of the Hartford Electric Light Company. An illustrated description of the largest turbine generating apparatus in the United States. 1800 w. Elec Rev, N Y—May 17, 1902. No. 48142.

Superheated Steam.

The Use of Superheated Steam. W. H. Wakeman. Considers some points that are disadvantages in the use of superheated steam. 1500 w. Elec, N Y—May 21, 1902. No. 48152.

Superheater.

The Cruse Patent Controllable Superheater. Illustrated description of an improved form. 1300 w. Prac Engr—May 16, 1902. No. 48343 A.

Thermodynamics.

Analysis of the Steam-Engine Cycle. R. H. Thurston. A study in thermodynamics. Discusses Rankine's formula. 1600 w. Sib Jour of Engng—April, 1902. No. 47828 C.

Valves.

Modern Practice in Rocking Valves and Valve Gears. H. F. Schmidt. Considers some of the different types of valves and valve gears employed in modern steam engine practice, with reasons for the modifications of the original Corliss type. Ill. 6500 w. Am Elect'n—June, 1902. No. 48308.

The Phoenix Steam-Pressure Regulating and Automatic Cut Off Valves. Descriptive account with illustrations. 1200 w. Engng—April 25, 1902. No. 47882 A.

MISCELLANY.

Aeronautics.

Aerial Navigation (Ueber die Frage der Luftschiffahrt). Prof. Georg Wellner. An illustrated review of navigable balloons and flying machines, with a plea for machines driven upward by a propeller with vertical shaft. Also illustrations of apparatus for showing stream lines in air. 6000 w. Zeitschr d Oesterr Ing u Arch Ver—May 2, 1902. No. 48223 B.

New Airships Under Construction for the British War Office. Illustration and description of Dr. Barton's aeroplane airship. 1300 w. Sci Am—May 3, 1902. No. 47852.

Exhibition.

The Düsseldorf Exhibition. Illustrated detailed descriptions of the more striking industrial products exhibited, showing the great progress in the German industries. 1500 w. Engng—May 9, 1902. No. 48181 A.

The Düsseldorf Exhibition. A descriptive account of interesting exhibits, especially in metallurgy and mechanics. 3000 w. Engng—May 16, 1902. No. 48365 A.

Explosives.

The Evolution of Smokeless Powder and Other High Explosives. A review of the development, discussing the shape of the powder, bursting charges, etc. 5200 w. Engng—May 2, 1902. No. 48061 A.

The Manufacture of Gun-Cotton Charges. Illustrates and describes a new method of compressing gun-cotton for charges of locomotive torpedoes, shells, submarine mines, etc. 2700 w. Engng—May 9, 1902. No. 48182 A.

Gun.

The New 15-Pounder Quick-Firing Field Artillery Gun. Full description with detail drawings and illustrations of the new German quick-firing field artillery gun of 3 in. calibre, together with its carriage. After a series of exhaustive trials this gun has been adopted for service in the British army. 3000 w. Engr, Lond—May 16, 1902. No. 48366 A.

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Heating.

Hot-Water Heating from a Central Steam Plant. Illustrated description of a system employed to utilize old hot-water heating installations by warming the water in special heaters connecting with a central plant. 1000 w. Eng Rec—May 10, 1902. No. 48004.

Index.

Technical Index and File. R. H. Soule. An illustrated description of the system used is given. 1200 w. Trans Am Soc of Mech Engrs, No. 0947—May, 1902. No. 47985.

Laboratory.

A New Government Laboratory and Its Work. George Steiger and E. T. Allen. Illustrated description of these new laboratories and their equipment. 2000 w. Eng & Min Jour—May 10, 1902. No. 48034.

Mechanical Plant.

The Mechanical Plant in the University Club, New York City. Illustrated description of the plant for heating, ventilation, electric light and elevator service in a leading New York club-house. 2300 w. Eng Rec—May 3, 1902. No. 47861.

The Mechanical Plant of the Frick Building, Pittsburg. Illustrated description of the installation in a 20-story office building, embracing 1200-h.p. in water-tube boilers, four 150-KW. generating units, 11 long travel hydraulic elevators, a refrigerating plant and a special system of electric wiring. 3100 w. Eng Rec—May 17, 1902. No. 48128.

Refrigeration.

Analyzing the Compressor. Gardner T. Voorhees. Begins an investigation into the economical action of the compression refrigerating machine. 1100 w. Ice & Refrig—May, 1902. Serial. 1st part. No. 47897 C.

Refrigerating Plant in Berlin. R. Stetefeld. An illustrated description of a modern municipal cold storage and ice-making plant in Germany. 4700 w. Ice & Refrig—May, 1902. No. 47895 C.

Sand Blast.

The Sand Blast (Die Sandstrahlgebläse). Ernst Schulz. An illustrated general review of the sand blast and the various kinds of apparatus for producing the blast. Serial, 2 parts. 8000 w. Zeitschr d Ver Deutscher Ing—May 10 and 17, 1902. No. 48239 each D.

Vacuum Pumps.

A Study of Vacuum Pumps (Etude sur Pompe Sèche). E. Portemont. A discussion of the air pumps used in drying beet roots in sugar refineries, with suggestions for improved valve and valve gear, with diagrams. 2500 w. Revue Technique—April 10, 1902. No. 48297 D.

Wire Drawing.

See Mining and Metallurgy, Iron and Steel.

MINING AND METALLURGY

COAL AND COKE.

American Exports.

American Coal in France (Les Charbons Americains en France). A. de Gennes. A review of the conditions, particularly in the United States, which have led to the export of coal to France. Map and diagram. 2500 w. Mem Soc Ing Civils de France—Feb., 1902. No. 48408 G.

Australia.

The Coal Resources of Australia. James Stirling. Report of a lecture in London. A Review of the coal-beds of the separate colonies, with illustrations. 2000 w. Col Guard—May 9, 1902. No. 48169 A.

Calorific Power.

The Heating Effect of Coal. W. R. Crane. Gives a simple method, with a description of apparatus which may be constructed easily and at small cost, which will permit such tests to be made with ease and dispatch and a fair degree of accuracy. 4000 w. Mines & Min—May 1902. No. 48010 C.

Coal Mining.

A Comparison of Coal Resources and Coal Getting. A. S. E. Ackermann. A critical comparison of British and American coal mining practice, showing the cost reductions effected by mining machinery. 3000 w. Engineering Magazine—June, 1902. No. 48393 B.

Coking.

The Manufacture of Coke from Compressed Fuel. John H. Darby. An account of results obtained with compressed fuel and the benefits derived. 2300 w. Ir & Coal Trds Rev—May 9, 1002. No. 48171 A.

The Recovery of By-Products in Coke-Making. J. Thiry. On the advantages of the Otto-Hilgenstock coke-oven, with report of tests with regard to temperature, draught and duration of the coking process. 3500 w. Ir & Coal Trds Rev—May 9, 1902. No. 48174 A.

Düsseldorf Exposition.

The Exhibit of the Dortmund District Society of Mining Industry at the Düssel-

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dorf Exposition (Die Kollektwausstellung des Vereins für die Bergbaulichen Interessen im Oberbergamtsbezirk Dortmund auf der Düsseldorfer Ausstellung 1902). Hr. Hecker. A review of an exhibit of coal mining, mining machinery, etc., with plan. 3500 w. Glückauf—April 26, 1902. No. 48258 B.

Germany.

A Brief Review of the Coal Reserve and Mining Conditions in Germany. A summary analysis of a description given in a volume circulated by the Dortmund Coal-owners' Assn. 2000 w. Ir & Coal Trds Rev—April 26, 1902. No. 47889 A.

Inspection.

Coal Mines Inspection in 1901. Report of the Swansea district. 1800 w. Col Guard—May 16, 1902. No. 48357 A.

Coal Mines Inspection in 1901. A report of the West Scotland district. 3300 w. Col Guard—May 9, 1902. No. 48168 A.

Iowa.

Character and Strategraphical Peculiarities of the Southwestern Iowa Coal Fields. Charles R. Keyes. Describes these deposits, giving analyses. 700 w. Eng & Min Jour—May 10, 1902. No. 48036.

Mining Plant.

The Ehrenfeld Plant of the Webster Coal and Coke Co. Illustrated description of a large modern plant containing a number of novel features. 6200 w. Mines & Min—May, 1902. No. 48006 C.

North-West Territories.

Coal Mining in the North-West Territories and Its Probable Future. Frank B. Smith. A general outline of the coal-mining of this region and its value. 4000 w. Can Min Rev—April 30, 1902. No. 47902 B.

Progress.

Colliery Engineering Progress. C. M. Percy. Describes the Lancashire boiler, its proportions and method of construction; discusses early practice in smoke prevention, etc. 3500 w. Mines & Min—May, 1902. No. 48012 C.

Rhenish-Westphalian Syndicate.

The Report of the Rhenish-Westphalian Coal Syndicate for 1901 (Vorstandsbericht des Rheinisch-Westfälischen Kohlensyndikats über das Jahr 1901). A review of the report of the board of directors of this great German syndicate covering production, transportation, exports, etc. 2000 w. Glückauf—April 26, 1902. No. 48259 B.

Schnablegger's Coking Process.

Schnablegger's Process for Coking Saw Dust, Peat and Brown Coal (Schnablegger's Verfahren Sägespäne Torf, Lignit und Braunkohle zu Vercoken). F. Toldt. An account of a process part of which is still secret, with illustrations of the coke. 1000 w. Oesterr Zeitschr f Berg u Hüttenwesen—April 12, 1902. No. 48262 B.

Volcanic Action.

The Spanish Peaks Coal Region in Southern Colorado. Arthur Lakes. An illustration of the effects of volcanic action on coal seams. Ill. 2000 w. Mines & Min—May, 1902. No. 48013 C.

COPPER.

British Columbia.

British Columbia—Boundary Mining District—Progress in Mining and Smelting. William M. Brewer. Illustrated description of interesting features of this district where mining and smelting are carried on at less cost than at any other place in North America. 4300 w. Eng & Min Jour—May 3, 1902. No. 47956.

The Ore Deposits of the Boundary District, B. C. R. W. Brock. Read before the Can. Min. Inst. The district treated of occupies a foremost place in British Columbia lode mining and is one of the most important districts in Canada in the production of copper. 3500 w. B C Min Rec—May, 1902. No. 48088 B.

The Production of Copper in the Boundary District, B. C. Dr. Albert R. Ledoux. Describes the characteristics of the ore deposits, and gives costs and general information. 2500 w. Can Min Rev—April 30, 1902. No. 47901 B.

Converters.

Copper Converters (Les Convertisseurs pour Cuivre). P. Jannetaz. An extended review of the theory and practice of converters used in copper metallurgy, with particular account of the Manhes and David system, and the "selecting" process of the latter. 1 plate. 8000 w. Men Soc Ing Civils de France—Feb., 1902. No. 48410 G.

Metallurgy.

The Wet Process and Cementation in the Metallurgy of Copper (La Metallurgie du Cuivre par Voie Humide et la Cementation). Paul Chalon. A review of copper metallurgical methods. 4000 w. Rev Univ d Mines—Feb., 1902. No. 48416 H.

Mexico.

The Cananea Copper Camp. G. E. P. Smith. Illustrated description of this camp which is the most modern in its equipment and methods of those in this vicinity. 900 w. Min Rent—May 22, 1902. Serial. 1st part. No. 48326.

Production.

The World's Copper Production. Horace J. Stevens. Gives the amount and relative production of the various countries, states, and mines, and discusses the pros-

pects for the coming year. 3000 w. Mines & Min—May, 1902. No. 48014 C.

Smelting.

Costs and Profits in Pyritic Smelting of Low-Grade Copper Ores. F. H. Prentiss. Describes method used and gives calculations and the data on which they were based. 1100 w. Min & Sci Pr—May 10, 1902. Serial. 1st part. No. 48097.

Small Smelting Works. Herbert Lang. Illustrates and describes a copper smelter in Southern California, and discusses the requirements of small smelters, and related matters. 3000 w. Min & Sci Pr—May 3, 1902. No. 48016.

GOLD AND SILVER.

Colorado.

Crestone Mining District in San Luis Park, Colorado. Arthur Lakes. Illustrates and describes a region containing some good veins favorably situated for economical mining, yielding gold, silver, and copper. 1100 w. Mines & Min—May, 1902. No. 48015 C.

Cyanide Mill.

The Portland Cyanide Mill. From Bulletin No. 5, South Dakota School of Mines. Illustrated description of the mill and the methods used. 2000 w. Min & Sci Pr—May 10, 1902. No. 48099.

Cyanide Plant.

The Cyanide Plant of the Wasp No. 2 Mining Co., Kirk, S. D. Illustration, with description of the plant and its equipment, methods used and cost. 2500 w. Min & Sci Pr—April 26, 1902. No. 47851.

Drainage.

The Drainage of the Prako Swamp, Thames. H. D. M. Haszard. Calls attention to the importance of reclaiming this district in New Zealand, and its value to the goldfields. 1000 w. N Z Mines Rec—April 16, 1902. No. 48156 B.

Gold Mining.

The Mining and Working of Gold. Brief review of methods of securing this precious metal, its working and the production in the United States. 2500 w. Sci Am Sup May 17, 1902. No. 48103.

New Zealand.

The Gold Deposits of New Zealand. Alexander McKay. Considered in relation to the comparative quantities of reef and alluvial gold on the various gold fields of the colony. 3400 w. N Z Mines Rec—April 16, 1902. Serial. 1st part. No. 48155 B.

The Kaimanawa Ranges, Hawke's Bay. Alexander McKay. An account of an expedition to examine certain parts where gold had been reported as occurring. Map. 3200 w. N Z Mines Rec—April 16, 1902. No. 48157 B.

Phase Rule.

Note on the Application of the Phase Rule to the Fusing Points of Copper, Silver and Gold. Theodore William Richards. Calls attention to results obtained by Holborn and Day in investigations published in this journal, and the theoretical interest attached to them. 700 w. Am Jour of Sci—May, 1902. No. 47833 D.

Transvaal.

Gold Mining in the Transvaal. Thomas Haight Leggett. Abstract of a paper read at meeting of Am. Soc. of Min. Engrs. A criticism of the paper of John Hays Hammond presented at the Richmond meeting last year. 5800 w. Eng & Min Jour—May 17, 1902. No. 48141.

IRON AND STEEL.

Alloys.

Alloys of Iron. Discusses various metals of importance because of the beneficial properties they impart to steel. 1200 w. Am Mfr—May 22, 1902. No. 48315.

Armor.

A New Krupp Armor. Gives illustrations of exhibition plates of this armor, and such information concerning it, as is now available. It is claimed to be hardly inferior to cemented plate, and applicable to any form or shape required. 500 w. Engr, Lond—May 16, 1902. No. 48367 A.

Blast Furnaces.

A New System of Cooling Tuyeres for Blast Furnaces. Horace Allen. Deals with the Foster System, bringing forward some new facts. 1800 w. Ir & Coal Trds Rev—May 9, 1902. No. 48173 A.

Method of Supplying Water to Furnace Tuyeres and Coolers. W. J. Foster. Describes improvements introduced in a plant at Darlaston, England. 2200 w. Am Mfr—May 1, 1902. No. 47920.

Recent Blast-Furnace Practice. Brierly Denham Healey. Read before the Soc. of Engrs. A comparison between old and new methods, with some results of recent working and illustrated description of furnace. 2700 w. Mech Engr—May 17, 1902. Serial. 1st part. No. 48353 A.

The Combined Blast-Furnace and Open-Hearth Furnace. P. Eyermann. Illustrated description of the furnace and its working, with an account of the evolution of the process. 7500 w. Ir & Coal Trds Rev—May 9, 1902. No. 48175 A.

The Largest Charcoal Blast Furnace in the World (Der Grösste Holzkohlen-Hochofen der Welt). An illustrated description of a blast furnace 70 ft. high, with a maximum production of 115 tons of iron per day, using charcoal fuel, at Vares, Bosnia. 1200 w. Stahl u Eisen—May 1, 1902. No. 48249 D.

We supply copies of these articles. See page 651.

Blow Holes.

Blow Holes and Pipes in Ingot Steel (Die Blasen und Lungerbildung des Flusseisens). A. v. Dormus. Illustrated descriptions of blow holes and pipes in steel, with mechanical and chemical methods for preventing them. 1000 w. Zeitschr d Oesterr Ing u Arch Ver—April 11, 1902. No. 48221 B.

Blowing Engine.

New Blowing Engine for the Pastuchoff Anthracite Blast Furnaces at Sulin, South Russia (Neue Gebläsemaschine für die Pastuchoffschen Anthracithochöfen in Sulin, Südrussland). Oscar Simmersbach. An illustrated description of a blowing engine built by the Allis Co. of Milwaukee, U. S. A. 1 Plate. 800 w. Stahl u Eisen—May 1, 1902. No. 48248 D.

Brazil.

The Iron Ores of Brazil. H. Kilburn Scott. Describes the deposits which the writer considers probably the most important known iron ore deposits in the world Gives also information concerning their manufacture. 4000 w. Ir & Coal Trds Rev—May 9, 1902. No. 48177 A.

Carbon.

The Chemical and Physical Properties of Carbon in the Hearth of the Blast Furnace. W. J. Foster. Gives results obtained by various experimenters, and the investigations of the writer. 2800 w. Ir & Coal Trds Rev—May 9, 1902. No. 48176 A.

Constitution.

On the Equilibrium of Iron-Carbon Systems. G. Charpy and L. Grenet. Translated from the *Bulletin de la Société d'Encouragement*. Experimental investigations of the constitution and chemistry of metals formed of combustions of iron and carbon. 1400 w. Engng—May 9, 1902. No. 48185 A.

Direct Process.

The Direct Production of Iron (Unmittelbare Eisenerzeugung). C. Otto. From the *Chemische Zeitung*. An addition to former articles of the author, describing a process of producing iron direct from the ore in a closed furnace under pressure. 700 w. Oesterr Zeitschr f Berg u Hüttenwesen—April 26, 1902. No. 48266 B.

German Exports.

German Iron Exports (Die Ausfuhrbestrebungen des Deutscher Eisengewerbes). An account of the efforts of the German iron trade to increase exports, with noteworthy results, and tables showing the exports of Germany, England, Belgium and the United States. 1500 w. Glückauf—April 19, 1902. No. 48257 B.

Ingots.

The Influence of Chemical Composition on Soundness of Steel Ingots. Axel Wahlberg. States the new theory based on recent researches, and gives the general principles of the formation of pipe and blow holes, describing the various types of ingot and Brinell's diagrams summarizing the results of researches. Ill. 8000 w. Ir & Coal Trds Rev—May 9, 1902. No. 48178 A.

Iron Industry.

The Old and New Iron Industry Compared. John Birkinbine. A brief resumé of the development of the iron and steel industry in the United States. 4200 w. Can Min Rev—April 30, 1902. No. 47906 B.

Krupp Exhibit.

The Krupp Exhibit at the Düsseldorf Exposition (Rheinisch-Westfälische Industrie-Ausstellung Die Krupphalle). An illustrated review of the Krupp exhibit of armor, turrets, cannon, shafts and all kinds of steel work at this large German Exposition. 1500 w. Stahl u Eisen—May 15, 1902. No. 48270 D.

Lorraine Ore.

The Minette Deposits of Lorraine (Die Minetteablagerung des Lothringischen Jura). Dr. Kohlmann. An illustrated comprehensive geological review of the extensive oölithic iron ore deposits of Lorraine, in Southern Germany, Northern France, Luxemburg and Belgium. Serial. 1st Part. 4500 w. Stahl u Eisen—May 1, 1902. No. 48250 D.

Magnetic Separator.

The Fröding Magnetic Separator (Frödings Magnetischer Erzscheider). From *Tecknisk Tidskrift*. An illustrated description of a Swedish magnetic separator, in successful operation at Herräng, which has a flat conical table revolving over electromagnets. 500 w. Glückauf—April 12, 1902. No. 48254 B.

The Thomson-Houston Magnetic Separator (Séparateur Magnétique Thomson-Houston). A brief illustrated description. 400 w. Génie Civil—May 10, 1902. No. 48289 D.

Mixer.

The Jones Mixer Decision. A review of the case of the Carnegie Steel Co. Ltd., against the Cambria Iron Co., interesting and valuable for the historical data furnished relative to the evolution of Bessemer practice in the United States. 4800 w. Ir Trds Rev—May 22, 1902. No. 48320.

Nickel Steel.

Nickel Steel and Magnetic Observation. Crittenden Marriott. Concerning the very peculiar magnetic properties possessed by nickel steel alloys. 800 w. Elec Wld & Engr—May 10, 1902. No. 48040.

Open-Hearth.

The Elimination of Silicon in the Acid Open-Hearth. Andrew M'William and

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William H. Hatfield. An account of investigations made of "sand boils" and other similar matters as to their effect on steel. 2000 w. Ir & Coal Trds Rev—May 9, 1902. No. 48172 A.

Production.

The Production of Iron Ore in 1901. Summary of a report by John Birkinbine. All records of production exceeded. 2000 w. Ir Age—May 15, 1902. No. 48093.

Rails.

Specifications for Steel Rails. William R. Webster. Abstract of a paper presented at meeting of the Am. Soc. of Min. Engrs. States the present situation of rail specifications and the importance of discussion of the proposed modifications. 1100 w. Eng & Min Jour—May 17, 1902. No. 48140.

Wire Drawing.

Modern Practice in Wire Drawing (Die Moderne Praxis des Drahtziehens und ihre Ergebnisse). Wm. Garrett. A review of wire-drawing mills and methods, particularly in the United States. 3000 w. Stahl u Eisen—May 15, 1902. No. 48271 D.

MINING.

Bendigo.

Air Compressing Machinery. Johan Sarvaas. Read before the Australian Inst. of Min. Engrs. An account of its use in the Bendigo goldfields, and its many advantages as a power for underground work. Also notes defects of air compressors. 2800 w. Aust Min Stand—April 10, 1902. No. 48158 B.

Blasting.

Precautions to be Observed in Blasting (Emplois des Explosifs). H. Ramu. A discussion of the causes of blasting accidents in mining and quarrying due to delayed shots, etc., and recommendation of precautions to be observed. 1600 w. Bull Soc d'Encouragement—April, 1902. No. 48292 G.

Compressed Air.

Compressed Air for Mining from Electric Power. John B. Tregloan. A record of results obtained with a 10 x 18-inch duplex, single-stage belt driven compressor. Ill. 1900 w. Min & Sci Pr—April 26, 1902. No. 47850.

Dynamite.

The Care and Use of Dynamite. A. W. Warwick. Directions for storing, thawing, preparing cartridges and using. 1400 w. Min Rept—May 22, 1902. No. 48327.

Electric Blasting.

The Wiring Circuits for Electric Blasting (Die Shaltung der Sprengschüsse bei Elektrischer Zündung). Hr. Heise. A discussion of series, parallel, and combined systems of wiring where more than one shot are to be exploded. Diagram. 2000 w. Glückauf—April 12, 1902. No. 48253 B.

English Mines.

The Distribution of Power in English Mines. Sydney F. Walker. Discusses the horse, and the factors which enter into the expense of haulage by animal power. 2000 w. Mines & Min—May, 1902. No. 48009 C.

Exposition.

The Charleston Exposition. Arthur L. Parsons. A brief survey of the mining features shown in the exhibits from the different states. 2200 w. Mines & Min—May, 1902. No. 48011 C.

Hoisting.

Graphical Methods in the Study of the Equilibrium of Hoisting Cables (Application de la Méthode Graphique à l'Etude de l'Equilibre des Cables d'Extraction). Henri Deschamps. A discussion of graphical methods for determining the varying weights of cable and power required in hoisting from deep shafts. Diagrams. 4 Plates. 7000 w. Rev Univ d Mines—April, 1902. No. 48420 H.

New Hoisting Engine Plants at Friedrichstahl. Rhenish-Prussia (Neue Fördermaschinen-Anlagen der Königlichen Berginspektion IX, Friedrichsthal). H. Deichmann. A description of a powerful hoisting plant at mines in the Saar district, with illustrations and indicator diagrams. 2000 w. Glückauf—April 19, 1902. No. 48255 B.

Winding Plants for Great Depths. Hans C. Behr. Read before the Inst. of Min. & Met. (England). Outlines the various systems that have been tried or suggested, explaining the mechanics of the problems, etc. The present paper considers only vertical winding. An important paper on this subject. Ill. 10500 w. Ir & Coal Trds Rev—May 16, 1902. Serial. 1st part. No. 48371 A.

Mine Flood.

Cardigan Proprietary Disaster. An account of this disaster in Australia, with editorial comment. 2000 w. Aust Min Stand—March 27, 1902. No. 47847 B.

Mining Industries.

A Review of Recent Progress in the Mining Industries of the United States. F. Lynwood Garrison. An address of the retiring president. 2200 w. Jour Fr Inst —May, 1902. No. 47995 D.

Mixed Sulphides.

Treatment of Mixed Sulphide Ores Containing Zinc by Hydrometallurgical Processes. Walter Renton Ingalls. Treats of the wet processes in which the zinc is brought into solution and precipitated by chemical reagents. 5000 w. Eng & Min Jour—May 3, 1902. No. 47957.

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Oil Prospecting.

Prospecting for Oil in the Region of the Cliff Dwellers of Southwestern Colorado. Arthur Lakes. Describes the formations and discusses the possibilities of their containing oil. Ill. 3300 w. Mines & Min —May, 1902. No. 48007 C.

Ore Dressing.

Problems in Ore Dressing. A. W. Warwick. Considers some difficult separations of refractory ores, and the methods being tried. 1800 w. Min Rept—May 8, 1902. No. 48042.

Pumping.

The Harris System of Pumping by Compressed Air, as Applied at the Deloro Mine. J. P. Kirkgaard. Describes this installation and states its advantages. 2700 w. Can Min Rev—April 30, 1902. No. 47907 B.

Rock Drill.

The François Rotary Rock Drill (Note sur la Perforation Mécanique par Rodage Système A. et J. François). N. Orban. Illustrated description of rotary rock-boring machines, used in Northern French and Belgian coal mines. 3 Plates. 3000 w. Rev Univ d Mines—March, 1902. No. 48419 H.

Safety Lamp.

Experiments with the New Wolf Safety Lamp. Report presented to the French Committee on Firedamp by G. Chesneau. Illustrated description of the lamp with report of tests. The committee are of the opinion that the results show it to be safe enough for use in fiery pits. 1500 w. Col Guard—May 2, 1902. No. 48066 A.

Surveying.

See Civil Engineering, Measurement.

Ventilation.

A Simple Mine Ventilating Fan. Illustrated description of a simple ventilating fan, designed for metalliferous mines and small collieries. 1200 w. Col Guard—May 2, 1902. No. 48067 A.

Watering.

The Watering of Mines. Discusses the theories of Prof. Galloway, S. T. Evans and J. T. Robson on the subject of water as a preventive of explosions. 3500 w. Col Guard—May 16, 1902. No. 48356 A.

MISCELLANY

Alloys.

A Review on Alloys. Gustav Thurnauer. Considers combinations of metals, prepared in such a manner as to impart qualities not possessed by either constituent. Ill. 9000 w. Pro W Ry Club—April 18, 1902. No. 47945 C.

Beaumont.

Tankage Capacity of Beaumont Oil Field. Concerning the estimated capacity, cost, method of construction and quality of oil stored in the tanks already completed and under construction. 1000 w. Eng & Min Jour—May 10, 1902. No. 48035.

Corundum.

Mining and Concentration of Corundum in Ontario. M. F. Fairlie. A description of the mining of the ore and method of concentration as at present practiced by the Canada Corundum Company, with discussion of other methods in use. 3000 w. Can Min Rev—April 30, 1902. No. 47905 B.

Hungary.

The History of Mining in the Máramaros District, Hungary (Zur Entwickelungsgeschichte des Máramaroser Bergbaues). L. v. Schmidt and Ludwig Litschauer. A paper read at the Hungarian Mining Congress, 1901, and printed in *Bányázzati és Kohászati Lapok*, giving a general review of salt, metal coal, petroleum and other mining industries. 3500 w. Oesterr Zeitschr f Berg u Hüttenwesen—April 26, 1902. No. 48265 B.

Japan.

The Japanese Mining Industry, with Special Reference to Iron and Coal (Die Japanische Montanindustrie mit besanderer Berücksichtigung der Eisen- und Kohlenindustrie). E. Davidson. General statistics, with tables, abstracted from an article by A. Keppen in the Russian "Economic Review." Serial. Part I. 1500 w. Oesterr Zeitschr f Berg u Hüttenwesen—May 10, 1902. No. 48269 B.

Manganese.

The Manganese Deposits of Huelva Province, Spain (Die Manganerz-Lager der Provinz Huelva). Carl Doetsch. An account of the ores, analyses, mining industry and production. 2200 w. Oesterr Zeitschr f Berg u Hüttenwesen—April 19, 1902. No. 48264 B.

Russia.

Mines and Metallurgy in South Russia in 1901 (Les Mines et la Métallurgie dans le Midi de la Russie en 1901). A. Spillberg. A paper before the 26th Congress of Mine Operators of South Russia, giving a general review, particularly of iron and manganese. 6000 w. Rev Univ d Mines—Feb., 1902. No. 48417 H.

Saxony.

Mining and Metallurgy in Saxony in 1900 (Der Bergwerks und Hüttenbetrieb im Königreiche Sachsen im Jahre 1900). General statistics, with tables, from the "Jahrbuch für das Berg und Hüttenwesen in Königreich Sachsen." Vol. for 1901. 1000 w. Oesterr Zeitschr f Berg u Hüttenwesen—April 12, 1902. No. 48263 B.

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RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in March. A condensed record of the principal accidents, with remarks on the most serious ones. 3000 w. R R Gaz—May 9, 1902. No. 47968.

Block System.

The Introduction of the Block System on the Austrian Railways (Die Einführung des Fahrens in Raundistanz auf den Oesterreichischen Eisenbahnen). Ludwig Freund. An account of the change from the time-interval to the space-interval system of train operation, in Austria. 3500 w. Oesterr Wochenschr f d Oeffent Baudienst —April 19, 1902. No. 48216 B.

Fast Trains.

The Burlington Fast Mail. An account of the performance of these trains during the last two years, with comment. 900 w. Ry Age—May 16, 1902. No. 48139.

Fuel.

Fuel as an Important Factor in Railroad Operation. A. D. Parker. Read at meeting of the Rocky Mt. Ry. Club. Shows what a large expense fuel forms in the operation of a railroad, and discusses the losses and ways of lessening them. 2500 w. Ry & Engng Rev—May 3, 1902. No. 47964.

Speed.

Discussion on Speed of Passenger Trains. B. A. Worthington. A communication giving interesting ideas and information on this subject. Discusses the approximate difference in the cost of pulling a 7-car passenger train 100 miles on a 3-hour schedule, and the same train on a 3-hour and 20-min. schedule, particularly as to cost of fuel. 2400 w. Ry & Engng Rev—May 10, 1902. No. 48053.

Train Rules.

The Standard Code on the Chicago and North Western. Notes the principal features in which the code varies from the "Standard," as issued by the American Ry. Assn. 1700 w. R R Gaz—May 16, 1902. No. 48116.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Best Method of Handling Air Brake Work in Connection with Yard Testing Plant. Report of the committee to the Air Brake Assn. 2500 w. Ry Age—May 9, 1902. No. 48046.

Car Framing.

Graphical Method of Determining Stresses in Car Framing. J. H. Lonie. Gives diagrams with notes showing the application of this method. 1000 w. Am Engr & R R Jour—May, 1902. No. 47934 C.

Compressed Air Locomotives.

Compressed-Air Locomotives (Druckluftlokomotiven). M. Buhle and G. Schimpff. A well illustrated description of various compressed-air locomotives, particularly the system in use on the Western Railway of France, in and about Paris. 1 Plate. 4000 w. Zeitschr d Ver Deutscher Ing—April 26, 1902. No. 48228 D.

Continental Practice.

Features of Continental Locomotive Building. Chas. R. King. The first of a series of illustrated papers reviewing the latest European practice in locomotive construction. 5000 w. Engineering Magazine—June, 1902. No. 48395 B.

Corridor Cars.

Improvements in Bogie-Truck Corridor Cars (Neuerungen an Vierachsigen Durchgang-Personenwagen). Hr. Herr. A paper before the Verein Deutscher Maschinen-Ingenieure, giving a well illustrated description of new passenger cars on the Prussian State Railways and various details. 7 Plates. 4000 w. Glasers Annalen—April 15, 1902. No. 48241 D.

Dynamometer Car.

Test and Dynamometer Car, Chicago, Burlington & Quincy R. R. Drawings and particulars of this car and its equipment which has recently been thoroughly overhauled, with list of tests made. 2700 w. Eng News—May 15, 1902. No. 48110.

Locomotives.

Compound Duplex Tender Locomotive on the Mallet System (Verbund-Duplex-Tender-Lokomotive, System Mallet). An illustrated description of a 1-meter gauge locomotive with two sets of three-coupled driving wheels on the Mallet articulated system, built by the Swiss Winterthur works for the French "Departementaux" railway. 400 w. Schweiz Bauzeitung—April 26, 1902. No. 48275 B.

Compound Locomitives with Four Cylinders and Eight Driving Wheels (Note sur les Machines Compound à 4 Cylindres et 8 Roues Accouplées de la Compagnie des Chemin de Fer du Midi). A well illustrated description of compound locomotives, with four pairs of coupled drivers and pony truck, built by the Société Alsacienns, at Belfort, for the "Midi" Rv. Co., of France. 3 Plates. 3000 w. Rev Gen d Chemins d Fer—April, 1902. No. 48295 H.

Consolidation Engine for the Nickel

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Plate. Illustrated description of a heavy freight locomotive, ten of which have just been placed in service. 900 w. Ry Age—May 9, 1902. No. 48045.

Heavy Tank Locomotive for the Port Talbot Railway and Docks Company. Illustrates and describes a new type for mineral traffic. 450 w. Engng—April 25, 1902. No. 47881 A.

Metre-Gauge Fairlie Engines for the Burma Railway Company. An illustrated description of the most modern form of double-bogie engine. 2500 w. Engr, Lond—May 16, 1902. No. 48368 A.

Oil-Burning Locomotives (Locomotives Chauffées au Naphte et au Goudron). F. Barbier. A well illustrated description of various kinds of locomotives, in different countries, burning oil, naphtha and petroleum residues. 1 plate. 3000 w. Génie Civil—April 19, 1902. No. 48282 D.

Pennsylvania Standard Consolidation Engine. Illustrated description of standard freight locomotives of this road. 800 w. Ry Age—May 23, 1902. No. 48335.

Prairie Type Freight Locomotives with Traction Increasers—Atchison, Topeka & Santa Fe. Illustrated description showing some slight differences between this type as designed for freight and the passenger locomotives previously described. 450 w. R R Gaz—May 16, 1902. No. 48118.

Prairie Type Passenger Locomotive for the Illinois Central R. R. Illustrates and describes one of the three types of engines with the wide firebox which will take part in the tests to be made by this road. 1600 w. Ry & Eng Rev—May 17, 1902. No. 48144.

Standard Freight Locomotives of the Columbian Government. Illustrated description of a new type of engine for heavy freight service. 500 w. R R Gaz—May 16, 1902. No. 48119.

Mechanical Stokers.

Mechanical Stokers for Locomotives. Fred H. Colvin. The advantages of mechanical stokers are enumerated and the stoker invented by John W. Kincaid is described and illustrated. 2200 w. Trans Am Soc of Mech Engrs, No. 0935—May, 1902. No. 47974.

Oil Fuel.

Oil as a Locomotive Fuel in England. Illustrated description of the Holden system of using oil as locomotive fuel as at present used on the Great Eastern Railway of England. 1300 w. Ry Age—May 23, 1902. No. 48332.

Piston Valves.

The Piston Valve as Applied to the Locomotive. J. E. Dixon. Reviews the history of the application of piston valves to locomotives, considering the benefits derived. Ill. 3500 w. Wis Engr—April, 1902. No. 47822 D.

Rolling Stock.

Norfolk and Western Standard Equipment: Illustrated description. 1200 w. Ry Age—May 9, 1902. No. 48048.

Steel Cars.

The Use of Steel in Car Construction. J. W. Stokes. Considers the general features of steel cars and related subjects. 2800 w. St Louis Ry Club—April 11, 1902. No. 47846.

Test Car.

Burlington Route Test Car. Max H. Wickhorst. Illustrated detailed description of the car and account of the uses made of it. 2400 w. Ry Mas Mech—May, 1902. No. 47914.

Train Lighting.

Train Lighting Tests. E. L. French and W. J. Spence. From a paper presented at the meeting of the Northwest Ry. Club. An illustrated account of tests made to gain light on train lighting in general and especially on the use of storage batteries. 2000 w. Ry Age—May 23, 1902. No. 48333.

German Progress in Electric Lighting for Railway Cars. Information from Herr Wichert's address giving results of the experiments with various forms of electric lighting made in Prussia. 700 w. U S Cons Repts, No. 1349—May 23, 1902. No. 48-170 D.

Turntable.

See Electrical Engineering, Power Applications.

NEW PROJECTS.

Trans-Australia.

The Trans-Australian Railway. A review of the report of Mr. John Muir, the engineer who has been making a preliminary survey of the ground on which the projected line is to run. Map. 3000 w. Engr, Lond—May 2, 1902. No. 48054 A.

PERMANENT WAY & BUILDINGS.

China.

The Work of the German Railway Soldiers in China in 1900-1901 (Die Thätigkeit der Deutschen Eisenbahntruppen in China 1900-1901). Major Bauer. A paper before the Verein für Eisenbahnkunde, giving an extended review of work in building and repairing railways, bridges, etc., in the northern part of China, during the foreign military occupation. Serial. 2 parts. 18-000 w. Glasers Annalen—April 15, May 1, 1902. No. 48240 each D.

Grade-Crossing Gates.

Gates at Crossings of Railways and Roads (Wegschranken bei Eisenbahnen). Karl Stöcke. Brief, illustrated description of gates to be operated from one side of the track. 1 plate. 700 w. Oesterr Wochenschr f d Oeffent Baudienst—April 12, 1902. No. 48214 B.

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Shops.

New Shops at Du Bois, Pennsylvania. Illustrated description of the most important details, with particular reference to the locomotive shop, power house and round house. 2200 w. Am Engr & R R Jour—May, 1902. No. 47933 C.

Signalling.

Automatic Block Signals on the Philadelphia and New York Divisions of the Pennsylvania Railroad. An illustrated description of what is probably the most elaborate railroad plant, for so long a distance, in the world. It is equipped with automatic track circuit block signals for about 104 miles, the road being four tracked. 3800 w. R R Gaz—May 16, 1902. No. 48117.

Electric Signalling. W. R. Sykes' system is illustrated and described. 2400 w. Tram & Ry Wld—May 8, 1902. No. 48379 A.

Interlocking Construction and Specifications. C. O. Tilton. Abstract of a paper read at the Railway Signalling Club, in Chicago. A brief review of the points of importance in the construction. 1200 w. Eng News—May 15, 1902. No. 48113.

The Virtues of the Enclosed Automatic Disk Signal. A letter to the editor aiming to show that the disk signal is equally reliable with the semaphore. 1800 w. R R Gaz—May 9, 1902. No. 47966.

Station.

The New Station at Basle, Switzerland. Describes a very large new station being constructed at a level of about 10 ft. below that of the present building, and so involving the lowering of the whole permanent way, but without interruption of traffic. 2000 w. Engr, Lond—May 2, 1902. No. 48060 A.

Track Elevation.

Allegheny River Bridge and Track Elevation at Pittsburgh. An illustrated description of a new bridge made necessary by elevating the tracks of the Pennsylvania System. It is of the double-deck, lattice girder type. The work of removing the old bridge is described. 1500 w. R R Gaz—May 23, 1902. No. 48324.

Tracks.

Track Improvements on the Baltimore and Ohio. Maps and illustrated description of points where the most important betterments are being made. 1000 w. Ry Age—May 9, 1902. No. 48047.

TRAFFIC.

Competition.

Competition of Steam vs. Electric Parallels. C. H. Davis. From a paper read before the Canadian Soc. of Civ. Engrs. Outlines the laws of passenger traffic and discusses the effect of competition. 2000 w. Can Engr—May, 1902. No. 47919.

Trains.

Maximum Trains; Their Relation to Track, Motive Power and Traffic. E. E. R. Tratman. Discussing the question of maximum train and car loading, more particularly from the maintenance-of-way point of view, considering also the maintenance of equipment. General discussion follows. 29000 w. N Y R R Club—April 17, 1902. No. 48043.

STREET AND ELECTRIC RAILWAYS

Berlin.

The Berlin Combined Overhead and Underground Railway. P. T. J. Estler. Illustrated detailed description of this interesting engineering work. 3400 w. Tram & Ry Wld—May 8, 1902. No. 48377 A.

The Financial Prospects of the Berlin Elevated and Underground Railway (Betrachtungen zur Wirtschaftlichkeit der Berliner Hoch und Untergrundbahn). Hans Dominik. A discussion of the costs, traffic and profitableness of this railway, with favorable conclusion. 1200 w. Ill. Zeitschr f Klein und Strassenbahnen—March 16, 1902. No. 48279 C.

Boston Elevated.

A Description of the Feeder Requirements and Installation on the Elevated Section of the Boston Elevated Railway Company's System. C. H. Hile. Ill. 1200 w. Wis Engr—April, 1902. No. 47818 D.

Effect of the Boston Elevated on Traffic. An estimate of the value of the service rendered and the striking features of the present situation. 1100 w. St Ry Rev—May 20, 1902. No. 48339 C.

Cardiff.

Cardiff Electrical Tramways. An illustrated article giving the history of the undertaking, with description of the line and its equipment. 7000 w. Elec Engr, Lond—May 16, 1902. No. 48348 A.

Car Sanitation.

The Sanitary Condition of Street Cars in New York. George A. Soper, in the *Medical News*. Discusses ventilation, heating, crowding, etc. 3700 w. Sci Am Sup—May 3, 1902. No. 47855.

Chamonix.

The Fayet-Chamonix Electric Railway (La Traction Electrique sur la Ligne du Fayet à Chamonix). M. Auvert. A well illustrated description of the line, rolling

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stock and power stations of this railway near Mont Blanc. 2 plates. 5000 w. Rev Gen d Chemins d Fer—April, 1902. No. 48296 H.

Controllers.

Restrictions on the Controller Handle. J. R. Cravath. Discusses the principles involved in the appliances for regulating the rate at which current is turned on, their advantages and disadvantages. 2000 w. St Ry Jour—May 24, 1902. No. 48319 D.

Conversion.

Burnley Corporation Electric Tramways. Brief history of these tramways with an illustrated description of the conversion from steam to electricity. 3700 w. Tram & Ry Wld—April 17, 1902. No. 47863 B.

Electric Locomotives.

Speed Control of Electric Mine Locomotives. R. B. Williamson. An illustrated explanation of the construction of controllers and the reasons therefor. 3000 w. Mines & Min—May, 1902. No. 48008 C.

Electric Traction.

Electric Railways (Les Chemins de Fer Electriques). Léon Gerard. A general review of electric traction of all kinds and comparisons between it and steam traction with classification tables of electric railways. Serial. 1st part. 5000 w. Mem Soc Ing Civils d France—March, 1902. No. 48413 G.

Electric Traction Progress. Philip Dawson. Read at Northampton, England, before the Tramways Committee. A review of the history of electric traction in England. 5800 w. Elec Engr, Lond—May 16, 1902. No. 48349 A.

Problems of Electric Railways. J. Swinburne and W. R. Cooper. Abstract of a paper read before the Inst. of Elec. Engrs. Urges the claims of series distribution of power for railways, especially for short lines, such as the tube and suburban types. 8500 w. Tram & Ry Wld—April 17, 1902. No. 47866 B.

Funicular Railway.

The Vevey-Mont Pélerin Funicular Electric Railway. E. Bignami. An illustrated account of the application of gas power to the generation of electricity for the operation of a mountain cable railway near Vevey in Switzerland. 3000 w. Engineering Magazine—June, 1902. No. 48394 B.

High-Speed Tests.

The Berlin-Zossen Electric Railway. An account of the results so far obtained. 2000 w. Engng—April 25, 1902. No. 47885 A.

Interurban.

Interurban Railway Development in Western Pennsylvania. William Gilbert Irwin. Outlines the scheme of development in the vicinity of Pittsburg. 7500 w. St Ry Jour—May 3, 1902. No. 47955 D.

The Middleton Electric Tramways. An illustrated detailed description of an English electric tramway system connecting Middleton with Oldham. 2000 w. Tram & Ry Wld—April 17, 1902. No. 47864 B.

Light Railways.

Light Railways and Land Development. J. M. Hewitt and W. G. Rhodes. Describes the system of eight railways and methods adopted in Belgium and their effect on the value of land and property. 2500 w. Elec Rev, Lond—May 16, 1902. Serial. 1st part. No. 48351 A.

Locomotives.

Electric Locomotives (Elektrische Lokomotiven). Illustrated descriptions of a variety of electric locomotives built by the Allgemeine Elektricitäts Gesellschaft. 1200 w. Ill Zeitschr f Klein und Strassenbahnen—March 16, 1902. No. 48278 C.

Electric Locomotives for Both Rack and Adhesion Traction (Elektrische Lokomotiven für Zahnrad und Ahdäsionsbetrieb). M. Gaze. A well illustrated description of electric locomotives to be used in and about a large sugar refinery, which are to operate on a rack railway, as well as by ordinary adhesion. 4000 w. Zeitschr d Ver Deutscher Ing—April 26, 1902. No. 48229 D.

Michigan.

Houghton County Street Railway. Illustrates and describes a road for passenger service between various towns in the copper region. 5500 w. St Ry Jour—May 3, 1902. No. 47952 D.

Milan.

Milan Street Railways. Effren Magrini. An account of these railways in Italy, where the city owns the tracks but leases them to a private company. 3500 w. Munic Af—March, 1902. No. 47894 D.

Motor Equipment.

Selection of Street Railway Motor Equipment. Fred A. Jones. Read at meeting of the Southwestern Gas, Elec. & St. Ry. Assn. Gives a statement of efficiency showing great need of economy, and discusses what should be considered in the selection of the motor equipment. 1800 w. St Ry Jour—May 17, 1902. No. 48137 D.

Mountain Railway.

The Fayet-Chamonix Electric Railway Brief illustrated description of an interesting line 11.8 miles long, with steep gradients and sharp curves. 2000 w. Engng—May 2, 1902. No. 48064 A.

Newcastle-on-Tyne.

New Transportation System for Newcastle-on-Tyne. Illustrated description of

We supply copies of these articles. See page 651.

an electrically operated system and its cars. 4800 w. St Ry Jour—May 3, 1902. No. 47953 D.

Oerlikon Experiments.

Electric Traction on Normal Railways (Die Elektrische Zugförderung auf Normalen Eisenbahnen). A paper by Hr. Huber before the Zürich Engineers' and Architects' Society, partly abstracted from the *Schweizzerische Bauzeitung*. giving an account of experiments about to be made by the Oerlikon Co., using single-phase currents. 4000 w. Elektrotech Zeitchr—April 17, 1902. No. 48203 B.

Paris.

Metropolitan Railway of Paris. Abstract of the report of Lieut.-Col. Yorke, giving interesting facts and brief discussion of the applicability of the shallow tunnel system to London. 3500 w. Tram & Ry Wld—April 17, 1902. No. 47865 B.

The Paris Metropolitan Railway. C. H. Wordingham. Reviews the report of Lieut. Col. H. A. Yorke concerning this railway, summarizing the salient features of the construction and operation and commenting on points of interest. 2000 w. Elec Rev, Lond—April 25, 1902. No. 47874 A.

Paris-Arpajon.

The Paris-Arpajon Electric Railway (Chemin de Fer sur Route de Paris à Arpajon). G. Boeto. A well illustrated description of railway, power station and rolling stock. Both accumulator locomotives and motor cars are used. 1 plate. 5000 w. Génie Civil—April 26, 1902. No. 48-284 D.

Power Plant.

New Power Plant at Baltimore. Illustrated description of the reconstruction of the plant of the United Railways and Electric Co. 3000 w. Steam Engng—May 15, 1902. No. 48330.

Power Plant of the Hartford and Springfield Street Railway Co. Illustrated description of a direct-current generating station having compound condensing engines. 1400 w. Eng Rec—May 24, 1902. No. 48190.

Rail Welding.

Rail Welding (Schienenschweissungen). Karl Beyer. A discussion of rail welding. and a table of results of experience with the Goldschmidt aluminothermic process on German and Danish street railways. 1400 w. Schweiz Bauzeitung—April 19, 1902. No. 48273B.

Rapid Transit.

The Boston Rapid Transit Situation. Louis Bell. A critical study, discussing also the character of railway construction of the future and the mistakes of the past. 3300 w. Elec Rev, N Y—May 3, 1902. No. 47898.

The New Electric Rapid Transit Railway in Berlin, Germany. An illustrated description abstracted from a series of articles by Herr Langbein, published in the *Zeitschrift des Vereins Deutscher Ingenieure*. 5700 w. Eng News—May 15, 1902. No. 48114.

I. The New York Rapid Transit Commission's Plan for a System of Interborough Rapid Transit. II. The Proposition to Abandon the Construction of the Third East River Bridge at New York. Gives in the first article a communication recently presented at a meeting of the Commission, discussing it in the editorial in the II. article, in connection with the subject of abandoning the Third East River Bridge. 3500 w. Eng News—May 22, 1902. No. 48312.

Repair Shops.

New Repair Shops at Providence, Rhode Island. Illustrates and describes details of building construction, equipment, shop methods, method of keeping records, etc. 4000 w. St Ry Rev—May 20, 1902. No. 48-338 C.

Resistance.

Train Resistance. W. J. Davis, Jr. Discusses train resistance as affected by the interurban service of electric railways. Also comments on this paper, by engineers who have given special attention to the subject. 7500 w. St Ry Jour—May 3, 1902. No. 47954 D.

Shops.

The New Repair Shops at Providence. Illustrated description of one of the most carefully equipped of modern electric car repair shops. 2500 w. St Ry Jour—May 3, 1902. No. 47951 D.

Single Rail.

Improvements in A. Lehmann's Single-Rail System (Neuerungen an A. Lehmann's Einschienenbahn). Illustrated description of a single-rail road, at ground level, and cars for hauling freight and passengers by man or animal power. 700 w. Oesterr Wochenschr f d Oeffent Baudienst—May 3, 1902. No. 48219 B.

Suburban.

Grimsby and Cleethorpes Electric Tramways. Illustrated description of a line about six miles in length in which the overhead equipment is used. 1200 w. Tram & Ry Wld—May 8, 1902. No. 48378 A.

Syracuse, N. Y.

The Street Railway System of Syracuse, N. Y. An illustrated description of improvements which have greatly increased the efficiency of the road, with report of operation. 4200 w. St Ry Jour—May 3, 1902. No. 47950 D.

We supply copies of these articles. See page 651.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cts. per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
American Telephone Journal. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architect's and Builder's Magazine. *m.* New York.
Armee und Marine. *w.* Berlin.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, Eng.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Brick Builder. *m.* Boston, U. S. A.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin Scientifique. *m.* Liege.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Age. *m. New York.*
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical Times. *w.* London.
Electrical World and Engineer. *w.* New York.
Electrician *w.* London.

Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemist & Metallurgist. *m.* London.
Elektrizität. *b-w.* Leipzig.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *w.* New York.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Indian and Eastern Engineer. *m.* Calcutta.
Ingeneria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Assn. Eng. Societies. *m.* Philadelphia, U.S.A.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, Mass.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallographist. *qr.* Boston.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. w. San Francisco, U.S.A.
Mining Journal. *w.* London
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. m. Vienna.
Modern Machinery. *m.* Chicago.
Monatsschr. d Wurtt. Ver. f Baukunde. *m.* Stuttgart.
Moniteur Industriel. *w.* Paris.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Power Quarterly. New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineers' Club. *qr.* Philadelphia, U. S. A.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Railroad Digest. *w.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. ed Agr. *b-m.* Catania.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Steam Engineering. *m.* New York.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Telephony. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland Glasgow.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a. S.

IMPROVED MACHINERY

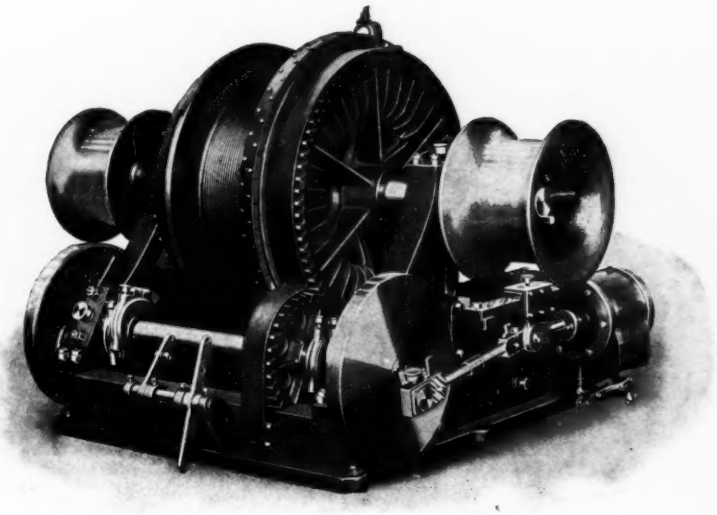
New Processes and New Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

Coaling at Sea.

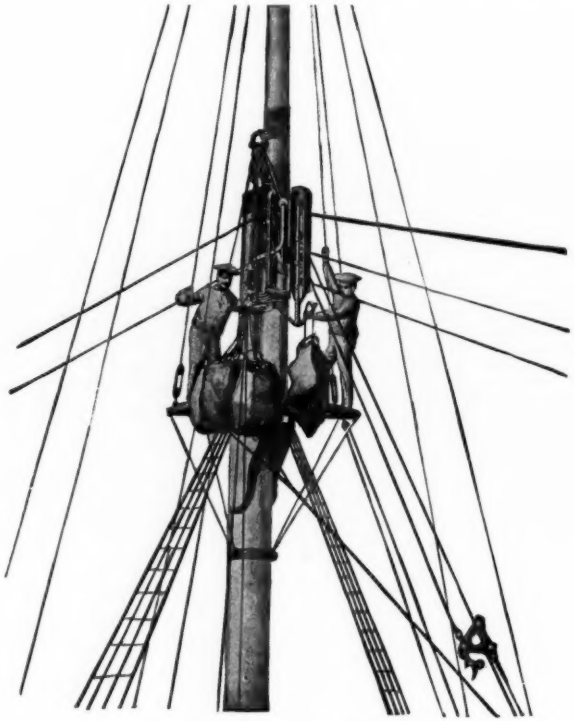
THE first marine cableways for coaling ship at sea were placed upon the collier rather than upon the ship to be coaled. The success of this method installed on the Lidgerwood-Miller system is well known, and in the most recent trials conducted by the British Admiralty with the collier "Muriel" in the Mediterranean, the amount of coal transported averaged 39 tons per hour for five hours, with the ships rolling heavily in such bad weather that at one time the hawser parted, while the highest record of these latest tests was 64 tons per hour, with loads of one ton. These trials were conducted entirely by naval officers, no representatives of the manufacturers being there.

The first warship to be equipped with a similar cableway is the U. S. S. "Illinois." The chief advantage of this system is that it will permit the battleship to take coal at sea from any masted vessel which it may meet in any quarter of the globe. The equipment requires two special winches, illustrated in the first figure, which have been so designed as to serve a double purpose. The winches originally located on the superstructure deck of the "Illinois" have been displaced by these two special winches, which serve all general purposes of the original machines, and in addition are adapted for operating the marine cableway when coaling at sea. In this manner there has been no essential increase to the machinery of the warship and no additional deck space has been required. The only additional equipment on



SLIPPING DRUM WINCH ON U. S. BATTLESHIP "ILLINOIS."

deck consists of a few deck bolts, a coil spring at the masthead, and two levers conveniently located on the after bridge. Just below the steering compartment and beneath the platform deck the remainder of the equipment is located. A reel suspended from the deck carries 2,000 feet of ⅞ inch sea anchor line. There are also two ⅜-inch conveyor lines and two sea anchors. There are also the haul-down block, carriage blocks, etc., all of which occupy a space just below the deck, 16 feet long, 7 feet wide and 4½ feet deep. The coil spring attached to the mainmast will be completely compressed under a load of 20,000 pounds, but a strain of 12,000 pounds only is developed in carrying a load of one ton. As the warship pitches and ascends, this spring will compress and elongate, thus serving to equalize the somewhat varying strain on the sea anchor. After the sea anchor has been located and the sea anchor line made taut, the tail block is hauled over and attached to the mast of the collier. This carries with it the conveyor line from one of the winches. At a point above the sea anchor line another lashing is made as shown in the second figure, and two ¼-inch wire guy ropes are there attached and led forward on an incline to the starboard and port sides of the ship, where they may be attached to the deck at almost any place found convenient. On these two inclined stays will run the two little elevating trucks, weighing only 37 pounds each, as shown in the lower part of the figure. Loads of one ton can be hoisted from the port deck and then the starboard deck, in alternation, to the masthead, where two men are located, as shown. One of these men takes in his hand the loose ring which is a part of the elevating hook. When the cable-



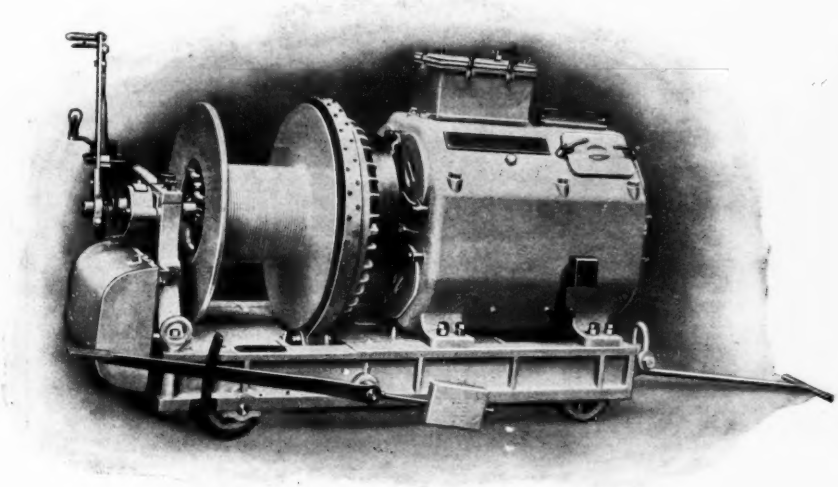
TRANSFERRING COAL AT COLLIER MASTHEAD.

way carriage reaches the collier's masthead the ring is placed by hand over the hook of the carriage, a lever is pulled on the elevating truck, and the load is dropped and thus transferred to the cableway carriage. This operation, by actual time, has been accomplished in two seconds. The other man at the masthead will take off the empty bags as they return from the warship and send them to the deck for refilling.

With the present arrangement the load starts out from the collier on a down-hill route and continues so for more than half the distance. When the load is just clear of the center of the span and in its lowest position the man on the warship commences to pull down the haul-down block, and by the time the bags reach this block they will be trailing on the deck. The operator then stops for an instant, lowering continues for a foot or more, the load is unhooked from the carriage, the empty bags put on and the whole lifted to its normal position. At the same time the operator sends the empty carriage back to the collier for another load. The capacity of this equipment should be 60 round trips per hour and the quantity delivered should not be less than 40 tons in the same time. The chief limiting factor in the capacity will be the ability of the men on the collier to feed the cableway.

Our third illustration shows an electric winch placed on the Russian battleship, "Retvizan."

By having our warships thus equipped the question of coal supply is largely solved, and solved with less cost than in any other way, since they can coal direct from any collier and are not dependent upon coaling stations.



ELECTRIC WINCH ON RUSSIAN BATTLESHIP "RETVIZAN."

Our navy needs a few colliers in peace times, and a great many in case of war. Any masted ship, either sailing vessel or steamship, can do duty as a collier and deliver its coal at sea to any warship equipped with a Marine Cableway. All colliers should also be fitted with Marine Cableways when time permits. Such colliers, however, should be fitted to deliver coal to the smaller warships in tow of the collier.

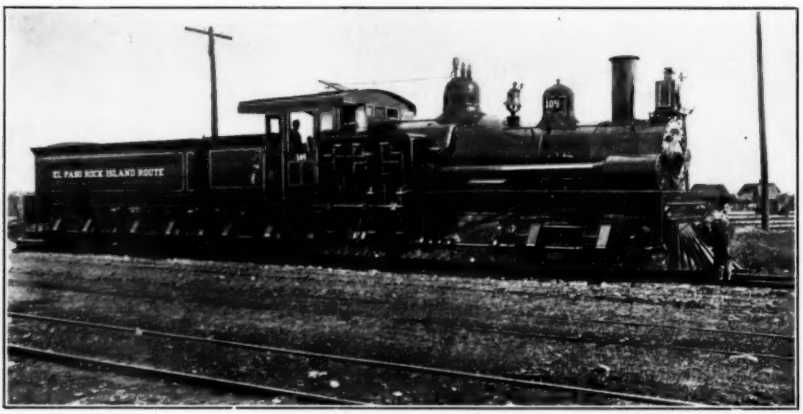
The Marine Cableway thus installed is intended to permit a fighting vessel to remain in the fighting line. It is intended to permit a fleet of war vessels to arrive off the coast of the enemy with their bunkers full instead of empty. Another phase of the questions relates to the possibility of the United

States becoming involved in war with a foreign power. In such case the merchant ships and coal carriers would probably fear to leave the home ports because of their liability to capture, and it is probable that the government would have offered to it an abundance of such vessels as coal carriers, at favorable prices, whether for purchase or for charter.

For further information concerning this matter, application may be made to the Lidgerwood Mfg. Co., 96 Liberty Street, New York City.

The Largest Geared Locomotive.

THE accompanying photograph illustrates a new Shay Patent Geared Locomotive, recently built by The Lima Locomotive & Machine Co., for The El Paso Rock Island and Route.



THE SHAY GEARED LOCOMOTIVE.

This locomotive is the heaviest on drivers ever built, which is shown by comparison with the recent heavy locomotives built by the Schenectady Works of The American Locomotive Company for the Atchison, Topeka & Santa Fe Railway, which have a weight on drivers of 232,000 lbs., whereas, the Shay locomotive has a weight on drivers of 291,000 lbs.; the weight on drivers of the Shay locomotive being also the total weight of engine and tender. The total weight of engine for the A. T. & S. F. Ry., is 259,800 lbs., and total weight of tender loaded 134,900 lbs., making a total for engine and tender 394,700 lbs. The Shay locomotive therefore, while not the heaviest in total weight, is heavier on the drivers than the heaviest direct connected engine built, up to the present time.

The principal features of the locomotive here illustrated are as follows: It is carried on four center bearing swiveled trucks with four wheels to each truck, or a total of 16 wheels, spread over a wheel base of 57 feet 4 inches. This distribution of weight gives an average wheel weight of 18,125 lbs., and enables the engine to be used on a lighter rail and sharper curves than direct connected locomotives of equal power, having shorter wheel bases, but a much longer rigid wheel base.

The long wheel base on this locomotive does not interfere with curving, since the trucks are free to swing independently of the engine frame, the engine taking curves with a minimum radius of 100 feet without producing destructive stresses on the track.

The engines are all self-contained, and cast in one piece, and are secured to the boiler through the medium of cast iron brackets with suitable steam and exhaust passages at top or cylinder end, and a cast-iron bed casting at bottom or crank shaft end, provision being made for the vertical expansion of the fire box. The power is conveyed from the engines to the driving wheels by a crank shaft and a horizontal shaft in sections, each section being provided with a universal joint and expansion coup-

lings, forming a shaft which is rigid in rotation but flexible in all other directions.

Among the features of the equipment of this locomotive is the matter of brake arrangement. To insure absolute safety in descending heavy grades with loaded train, a steam brake operating on all driving wheels has been provided for the engine; the engineer's valve being arranged so that the brake may be applied to engine and tender separately or together, Westinghouse air brakes being also provided for train service only.

This arrangement permits the engineer to make frequent applications of the train brake, and to keep the engine under control by means of the steam brake when releasing the air brake. The engine is also fitted with the LeChatelier water brake to relieve the tires from excessive heating due to continuous application of the steam brake. The design of this locomotive is the outcome of a desire of the operating department of the El Paso Rock Island Route to provide a machine that could be economically operated on the division laid with 60-pound rail, extending from Alamogordo, New Mexico, to Cox Canon, a distance of 31 miles, with a total elevation between terminals of nearly 6,000 feet, the grades ranging from 3 per cent. to a little over 6½ per cent., the latter grade being found near the summit of the division. There is a stretch of 4.5 to 5.2 per cent. grade for the distance of about 8 miles, with about ½ mile of 6 to 6½ per cent. grade, coupled with heavy curves.

A train of 27 cars, each weighing about 16,000 lbs., and a caboose weighing about 12,000 lbs., or a net train weight of 222 tons, making a total train weight, with engine, of 362 tons, was taken over the 6 to 6½ per cent. grade. This haulage is equivalent to 715 tons total train weight, or 575 tons net train weight on 3 per cent. grade.

As a locomotive adapted to heavy grade duty, giving a maximum of power at a minimum of cost, both as to the operating expense and repairs to engine and road bed, this engine will commend itself to motive power officials who have divisions of road similar to that described above, and from the arrangement of its wheel base it can be safely used over light bridges where direct connected locomotives of less weight would set up destructive stresses, by reason of the fact that most of their weight comes on a single bridge panel at one time. Any further information desired concerning these locomotives will be gladly furnished by the Lima Locomotive and Machine Company, of Lima, Ohio.

ARMSTRONG NIPPLE HOLDER.

Nipple Holder.

A NEW nipple holder has been made by the Armstrong Mfg. Co., of Bridgeport, Conn., to be used in connection with their No. 00 Pipe Threading Machine. It holds pipe from 1 inch to 4 inches inclusive by using different threaded rings and backing pieces. It will also hold close nipples either right hand or left hand, no change of parts being necessary to hold the nipple for threading it left hand. When the thread is cut, the nipple can be removed with the fingers by loosening the screw in the back of the holder. This nipple holder can be furnished to hold as small as ¾ inch if required.

Coaling Station at Manila.

ONE of the most potent factors in the government policy of holding the Philippine Islands was the advantageous position of Manila Harbor as a coaling station for war vessels in Eastern waters. The naval engineers decided that Sangley Point would be the best location for large coal pockets and coal handling machinery. Extensive wharves and fire proof buildings are being erected there for this purpose. The two coal sheds are each 194 feet wide and 300 feet long with an interval of 50 feet between them, while the wharf is 418 feet in length and 75 feet wide.

The coal-handling machinery was designed to remove the coal from colliers by means of hoisting towers, and distribute it

C. W. HUNT CARS.

in the storage sheds by automatic railways; also to coal the war vessels at the wharf from the shed. To do this to best advantage, required two steeple towers equipped with steam hoisting engines and duplex steam shovels, twelve automatic railways and over a mile of track. All this coal-handling machinery, together with accessories such as railway equipment, cars, coal tubs, etc., is being built by the C. W. Hunt Company, New York.

The photograph here produced shows thirty-six flat-top, four-wheel cars completed and recently shipped to the Philippine Islands. Each car is of one-ton capacity, to be used on the Hunt Industrial Railway, whose gauge is 21½ inches, out to out of rail heads, and which is admirably adapted for transporting material on wharves, ware houses, docks and shops.

Electrically Operated Air Compressors.

ONE of the most remarkable developments in the recent history of engineering progress is the constantly increasing use of compressed air as a medium for performing numerous and various industrial operations. Pneumatic tools and other appliances for the utilization of compressed air have been introduced into one field after another with such successful and gratifying results that the advantages of using compressed air for a wide variety of purposes are now fully recognized.

The present general use of electricity renders it advantageous to operate air compressors with electric motors. The convenience and economy of this method is apparent when it is remembered that an electrically driven compressor can be operated from any lighting power or railway circuit that may be available.

To meet the constantly increasing demand for an electrically driven, simple, compact air-compressing unit, the Christensen Engineering Company, of Milwaukee, are manufacturing a complete line of motor-driven compressors ranging in capacity from 7½ to 1,000 cubic feet of free air per minute. The smaller sizes are made for portable as well as stationary service. The following description of these machines will be of interest to our readers:

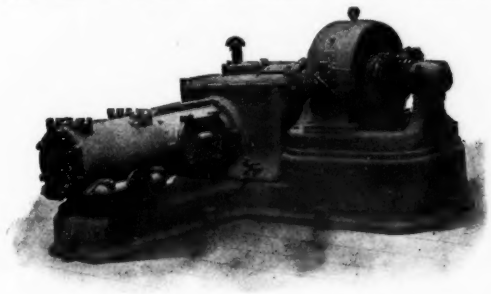
The type "M" motor-driven air compressor illustrated herewith, is for stationary continuous service. It is built in capacities from 50 to 1,000 cubic feet of free air per minute.

The electric motor and the compressor have been designed to form a compact self-contained unit. The air is compressed in the cylinder, shown on the left, by a double acting piston which is operated by means of a connecting rod and steel crank shaft. The latter is mounted in bearings located within the frame of the machine. This shaft carries on the motor end a helical gear which is driven by a pinion on the armature shaft of the motor. The entire machine is mounted on a substantial cast iron base.

Both the cylinder and the valve heads are water jacketed throughout. The clearance spaces have been reduced to the lowest practicable limit, thereby correspondingly increasing the economy.

The gear case and the crank chamber are connected and form an enclosure which is partly filled with oil, with which all the working parts are automatically and con-

tinuously lubricated, including the air cylinder. The latter is connected with the oil chamber so that the proper quantity of oil for lubricating the surface between the cylinder and the piston is automatically supplied and no sight feed lubricator is required. Experience has shown that, after being supplied with oil, the compressor runs for weeks before replenishing is necessary.



CHRISTENSEN TYPE M MOTOR-DRIVEN AIR COMPRESSOR.

Either an alternating or a continuous current motor may be used. The illustrations herewith show the continuous current multipolar type that the Christensen Company build for this service.

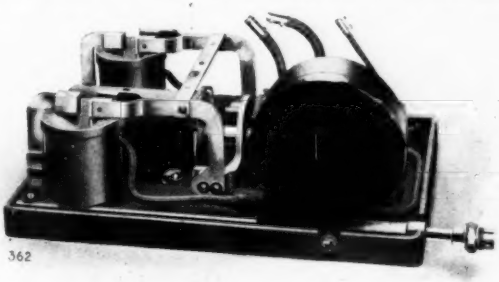
The design of the motor and compressor is such that every part is easily and quickly accessible. By unscrewing a few bolts the armature and the field coils can be removed or exchanged. The gear, pinion, valves or cylinder heads may also be removed without disturbing any other parts.

An automatic governor starts and stops the motor compressor at the desired minimum and maximum pressures. It is a very simple piece of apparatus consisting of an ordinary pressure gauge mechanism with a special hand which upon coming in contact with a conducting stud at the position of minimum pressure, allows current to flow through a magnet coil. This coil operates a plunger to which the contact pieces for the motor circuit are attached thereby closing the circuit and starting the motor.

As soon as the pressure reaches the desired maximum the hand strikes another stud and current passes through a second solenoid magnet thereby pulling the plunger in the opposite direction and opening the motor circuit. By this mechanism it is possible to get a close margin between maximum and minimum pressures. This margin is readily adjusted by moving the contact studs.

The governor is provided with a magnetic blow-out for extinguishing the arc and preventing the burning of the contact pieces. All the working parts are easily accessible for inspection and the governor is protected by a cover not shown in the illustration.

For portable service the Christensen Company mount their type "H" compressor (so well known in the electric railway field in connection with the Christensen air-brake equipments) with the automatic governor and air reservoir, on a suitable hand truck which can be easily and quickly moved wherever necessary. This portable outfit, known as type "I," has a very wide field of usefulness wherever pneumatic tools or other compressed air appliances are used and an expensive system of piping is not desirable. The compressor is taken to the work instead of transmitting the compressed air from a stationary compressor at a distance.



AUTOMATIC GOVERNOR FOR TYPE M COMPRESSOR.

These compressors are frequently mounted on a wagon instead of a hand truck, and transported by horses for use in drilling and

bonding rails, etc., in electric railway or other work where electric power can be obtained. It is only necessary to make a connection to the trolley wire by a hook or

CHRISTENSEN TYPE I PORTABLE AIR COMPRESSOR.

pole for the purpose of obtaining power for the motor.

It is also practicable to make the smaller sizes of the type "M" portable; especially where the truck, upon which the compressor is mounted, is arranged to run on rails.

More detailed information regarding these interesting types of compressors may be obtained by sending a request to the Christensen Engineering Co., Milwaukee, for a copy of catalogue No. 19.

Water Softening.

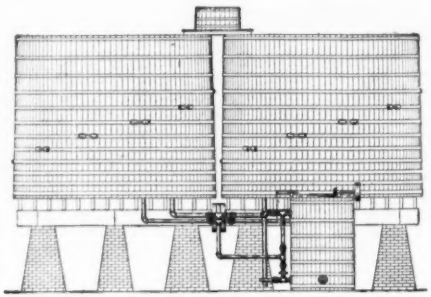
THE New York Continental Jewell Filtration Company have lately added a new department to their extensive water purification business, that of water softening for boilers and industrial purposes.

This is a method of removing the hardness or mineral impurities that well waters and many river waters carry in solution, and which is a source of enormous expense and trouble with many railroads, manufacturing establishments, etc. This line of work has been made a specialty by the Wefugo Company for a number of years. They, however, retired from business a short time since, the New York Continental Jewell Filtration Company purchasing their patents, patterns, unfinished stock, etc., and also forming connections with Mr. F. B. Leopold, who is thoroughly familiar with this department of water purification in all its branches, having been the General Superintendent of the Wefugo Company, and having had charge of the design and erection of their plants.

The illustration herewith presented is that of one of the standard types of the Intermittent Water Softening Plants, which has just been erected and put in operation for the Lackawanna Iron & Steel Company, Cornwall, Pa. This is the type of apparatus that is most highly recommended as combining simplicity of construction and operation to secure the best results with the least amount of technical knowledge required in its operation. The plant as shown consists essentially of two large settling or precipitating tanks, each holding sufficient water to supply the 800 H. P. boilers for six hours. Each tank is equipped with one of the Company's standard design agitating apparatus, which is operated by bevel gears set beneath the center of each tank, for properly mixing the solution, after the water is treated therewith.

The gears are operated by a line shaft run from a small motor set between the two tanks. A vertical shaft running up through the center of the tank carries the stirring arrangement for agitating the water, and the method of treatment is as follows:

The first tank is pumped full of the water



INTERMITTENT WATER SOFTENING APPARATUS.

which is intended to be used; the necessary amount of chemical reagent for treating the water is then dissolved in the small tank, set on top of and between the two large tanks.

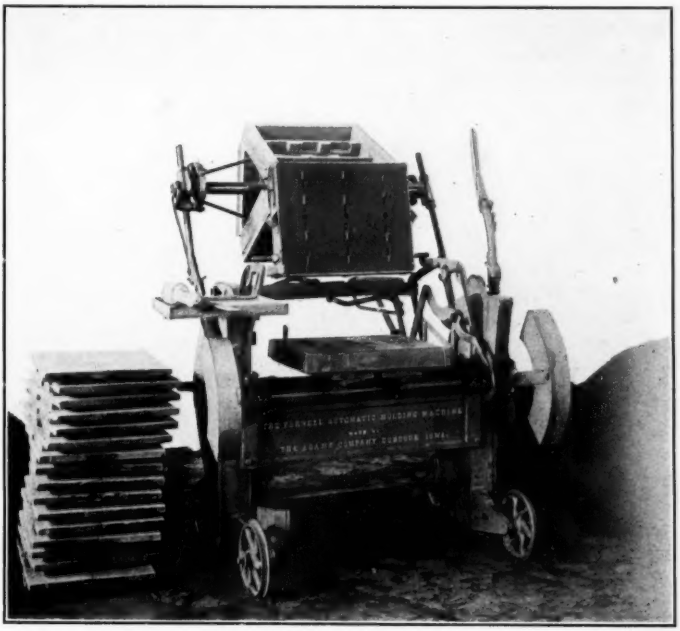
This solution is then run into the water and the agitating apparatus set in operation and allowed to run for such a length of time as is necessary to secure a complete and thorough mixture; the chemical reagents used combine with the mineral impurities in solution in the water, changing them from a soluble to an insoluble condition, in which condition they are precipitated to the bottom of the tanks.

As a complete precipitation, however, would require tanks of too great capacity, this mechanical part is assisted by the use in connection with the settling or precipitating tanks, of one of the Company's standard gravity filters. The water flows from the settling tank onto the filter bed, and the lighter precipitations or flocculent matter is here intercepted; the water then issues from the filter perfectly bright and clear, practically free from all mineral impurities in solution, and the results from this treatment have been universally satisfactory.

About one hundred plants of this type are in use, and the New York Continental Jewell Filtration Company, of New York City, are prepared to install plants of any required capacity for any industrial purpose desired, either of the Intermittent or Automatic Process and will be pleased to furnish detailed information to any parties who may be interested in this apparatus.

Automatic Molding Machine.

THE Farwell Automatic Molding Machine is designed to make a complete snap mold. It is used with solid iron tapering flask and match plates, or, as sometimes called, patterns on a plate. By a few rapid and easy motions, the operator allows the pattern plate to slide between the cope and drag, and after filling the drag with sand, and placing on the bottom board, the flask is turned over and the cope is then filled with sand, and the entire mold pressed at once.



FARWELL AUTOMATIC MOLDING MACHINE.

The turret top is arranged to do any special peining and can be made to cut sprues or draw flat gates automatically. The turret top is not necessary for all work, as peining can be done by making the presser board and bottom board of special design.

The operation of this machine is simple and anyone can become familiar with it in a few hours.

One of these machines is now in its ninth year of successful service in the foundry of The Adams Company, Dubuque, Iowa, who are the manufacturers. This machine has produced over 700,000 castings, weighing about 8 lbs. each, and from the outlook today it bids fair to continue its usefulness for many years.

Industrial Notes.

—The University of Wisconsin will hold the second session of its Summer School for Apprentices and Artisans from June 30 to August 8, 1902. This school is conducted under the auspices of the College of Engineering and is the first of its kind established, its first session having been held last year, when it proved highly successful. Its purpose is, primarily, to give Stationary Engineers, Superintendents of Power Stations, Machinists, Artisans, and apprentices in various trades, such mathematical, laboratory, and shop instruction as would be found of most practical value to persons in these employments and which could be imparted in the limited time of six weeks. Any person over sixteen years of age, speaking the English language and having a fair knowledge of arithmetic, will be admitted. The school has a faculty of ten, composed of regular professors and instructors from the faculty of the College of Engineering. Correspondence school students will find the opportunity for laboratory and shop work here offered particularly helpful. In case the classes of practical workers named above do not furnish all the students which can be accommodated, others will then be received as follows: Regular students in the College of Engineering who wish to do their shop work during the summer school; persons who wish to qualify themselves to teach manual training in high schools; and high school students who wish to get manual training practice. For more detailed information concerning this summer school send for Bulletin No. 44, to Prof. J. B. Johnson, Dean of the College of Engineering, Madison, Wisconsin.

—The Philadelphia Pneumatic Tool Co. is now entirely settled in its new shops at 21st Street and Allegheny Avenue, Philadelphia. Considerable loss of time naturally resulted from moving and the company reports being somewhat behind in making shipments. The works are being run night and day, however, to catch up and orders will be filled with usual promptness at no distant date. A great deal of attention is being attracted to the Keller Pneumatic Hammers made by the Philadelphia Company, by reason of a recently devised improvement in their construction. On account of this improvement the working capacity of the Chipping and Riveting Hammers is increased at least 25% and the vibration, inseparable from any pneumatic tool, is reduced very materially. This applies to both Chipping and Riveting Hammers. Recent large orders have been received from the Southern Pacific Co., Newport News Ship Building & Dry Dock Co., Pennsylvania Railroad Co., Lackawanna Steel Co. and others.

—The Steam Boiler Equipment Company of New York report that they have received many orders lately since the Anthracite Coal strike for the installation of their "Hydro-Carbon" System for prevention of all objectionable smoke in use of soft coal. Soft coal is now used almost entirely for all steam boilers, and many devices have sprung up as so-called "Smoke Consumers." The Steam Boiler Equipment Company have had their apparatus in use for several years in many cities, and were engaged in making many equipments for city plants for the purpose of changing plants from hard to soft coal, without smoke, from standpoint of economy and increased power. When the strike occurred, however, they suddenly found their apparatus in great demand, mail and telephone orders coming in from New York, Philadelphia and other places. They have made very successful equipments for many large manufacturing and electric plants, as well as public buildings, among which may be named: E. S. Higgins Carpet works, New York; R. Hoe & Co. Printing Press Works, New York; Empire

Laundry, New York; Imperial Laundry, New York; Hawley and Hoops, New York; Clausen & Sons Brewing Co., New York; Geo. V. Cresson & Sons, Power Transmitting Machinery, Philadelphia; Neafie and Levy Ship and Engine Building Co., Philadelphia; Jos. R. Foster & Sons, Philadelphia; Keystone Leather Co., Camden, N. J.; Baltimore Dry Dock Co., Baltimore, Md.; Potomac Electric Power Co., Washington, D. C. They have also done work in their Marine Department on several vessels and private steam yachts, such as the "Niagara," Mr. Howard Gould, owner; the "Nourmahal," Col. J. J. Astor, owner; the "Au Revoir," Chas. A. Gould, owner, and others.

—The Alberger Condenser Company of 95 Liberty Street, New York, has recently received an order for an important condensing equipment to be installed in the steam turbine testing room of the new shops of the Westinghouse Machine Company at East Pittsburg. This apparatus consists of an 8,000 sq. ft. Surface Condenser of the Alberger High Vacuum Type, a Corliss Two-Stage Dry Vacuum Pump and a Centrifugal Circulating Pump connected to a Westinghouse engine. Owing to the high vacuum desired in steam turbine practice, this condensing outfit is to maintain 28 inches of vacuum.

—The Sprague Electric Company has recently received an order from the Pennsylvania Steel Company for ten five ton electric trolley hoists for use in the new bridge shop at Steelton, Pa. These hoists are of the new type of worm gear trolley hoists manufactured by the Sprague Company. They combine extraordinary lifting capacity with remarkably light weight and unusual compactness. They are controlled from a cage and have a lifting speed of 20 feet per minute.

—The secretary of the Clyde Shipbuilders' Association, in conjunction with Messrs. John Macdonald & Sons, Glasgow agents for the Chicago Pneumatic Tool Company, which was recently amalgamated with the Tait-Howard Pneumatic Tool Company, with a capital of $10,000,000, has arranged for a six weeks' trial of pneumatic tools of all kinds in the yard of Messrs. Scott & Co., Greenock. Three of the best American workmen from the Chicago Company along with three of Messrs. Macdonald's men, started the work, which will be mostly on a merchant vessel of 8,000 tons. All kinds of shipyard work will be done—shell riveting, deck riveting, caulking, chipping, boring and reaming—so that all the different kinds of pneumatic tools will be experimented with. Practically all the leading shipbuilders in Great Britain have accepted the invitation of the Clyde Shipbuilders' Association to visit the yard while the work is being carried on, and arrangements have been made for having a specified number of them present each day of the six weeks, so that they may all have an opportunity of judging for themselves as to the merits of the work done by pneumatic tools. The definite and complete nature of the arrangements, and the unanimous way in which builders all over have agreed to inspect the tools and the work, shows that those interested in the industry are seriously considering the advisability of making important developments in the different yards.

—The Q. and C. Co., manufacturers of Railway Specialties, Machinery and Pneumatic Tools, will operate in their own name, commencing June 1st, with their principal offices in the Western Union Building, Chicago; their New York Office at 114-118 Liberty Street, and their General Sales Department located at their shops, Chicago Heights, Illinois.

—The University of Chicago recently placed an order with the American Blower Co. of Detroit, Mich., for two large fans.

—The Pittsburgh Gage & Supply Co., Pittsburgh, have been appointed direct representatives of the Weller Manufacturing Co., Chicago, for their line of elevating, conveying and power transmitting machinery.

—Johnson and Morton, of Utica, N. Y., the manufacturers of panel boards, switches and other electrical supplies, have opened a New York office at 232-234 Greenwich Street, where they will be represented by Messrs. Frorup and Levy, both of whom are well known to the electrical trade.

The Cleveland Pneumatic Tool Company have appointed The Compressed Air Machinery Company of San Francisco, Cal., to represent them on the Pacific coast.

—H. G. Barr has succeeded the firm of H. G. Barr & Co., manufacturers of ma-

chine tools and special machinery, and has removed to the corner of Winona and Nebraska Streets, Worcester, Mass.

Personal.

—Mr. C. Vandeventer was tendered a farewell dinner by his office associates and friends at the Hotel Normandie, New York City, on the evening of Monday, April 28th. The occasion was Mr. Vandeventer's leaving the New York office of the Stanley Electric Mfg. Company to take the management of that company's Chicago office. Among those present were Dr. F. A. C. Perrine, President of the Stanley Company, Messrs. M. D. Barr, Sales Manager, John F. Kelly, Consulting Engineer, T. W. Kloman, J. G. Otis, B. J. Hough, C. E. Bibber, L. H. Hobbs, Ray D. Lillibridge, Ward Arnold and Z. V. Taylor.

—Dr. F. A. C. Perrine, President of the Stanley Electric Mfg. Company, on the evening of Friday, May 9th, read a paper before the Boston Society of Arts at the Massachusetts Institute of Technology on "Success in Long Distance Power Transmission." The special features of the paper were "the obstacles and difficulties met with in the engineering of the great transmission lines of California" and the details of their successful solving. On Saturday morning Dr. Perrine delivered an informal talk to the Senior Class in Electrical Engineering of the Massachusetts Institute of Technology on "The Outlook in Electrical Engineering," the theme being the business prospects for young engineers. Dr. Perrine led the discussion on "Protection of Long Distance Transmission Lines" at the Cincinnati Convention of the National Electric Light Association.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Air Compressors.

Catalogue No. 51, well illustrated, devoted to air compressors, both stationary and portable, driven by electric motors. Christensen Engineering Company, Milwaukee, Wis.

Three circulars, devoted respectively to "straight-line" air compressors, "center-crank" belt-driven air compressors, and air receivres. Herron and Bury Mfg. Co., Erie, Pa.

Automobiles.

Neat pamphlet, with illustrated descriptions of Prescott steam vehicles and their details. Prescott Automobile Manufacturing Company, 83 Chambers St., New York.

Boiler Compound.

A pamphlet calling attention to the merits of the "Standard" boiler compound for preventing and removing boiler scale, with partial list of users and testimonials. Standard Boiler Compound Co., Bradford, Pennsylvania.

Boilers.

Catalogue No. 31, with handsomely illustrated descriptions of the new Walker boiler for hot-water and steam heating, and steam radiators. Also advance circular of the Crawford boiler for the same purposes. Walker and Pratt Mfg. Co., Boston, Mass.

Boiler-Tube Cleaner.

Booklet devoted to the X L C R boiler-tube cleaner, for mechanically removing the scale from water-tubes of boilers. C. & O. Schaefer Machine and Novelty Co., Louisville, Kentucky.

Chucks.

Illustrated catalogue of Westcott's patent lathe and drill chucks. Westcott Chuck Company, Oneida, N. Y.

Coal Handling.

Pamphlet No. 028, with illustrated examples of economic coal handling and conveying apparatus for large electric and pumping stations. C. W. Hunt Company. West New Brighton, Staten Island, N. Y.

Coaling at Sea.

A handsomely illustrated pamphlet describing the Lidgerwood-Miller Marine Cableway as installed on the U. S. Battleship "Illinois" and other vessels, for coaling ships at sea in all kinds of weather. Lidgerwood Manufacturing Co., 96 Liberty Street, New York.

Concentrators.

A pamphlet on the subject of ore concentration, with well illustrated descriptions of the New Standard Concentrator and the Elspass Centrifugal Four-Roller Quartz Mill. F. B. McCabe and Co., General Agents, Los Angeles, Cal.

Conveyors.

Handsome, completely illustrated, cloth-bound catalogue of 320 pages, showing modern methods applied to the elevating and conveying of materials and the transmission of power. The Link-Belt Engineering Company, Nicetown, Philadelphia, Pa.

Cotton Jacket.

Circular with description and price list of the "Universal" cotton jacket for weaving directly over rubber hose. Boston Belting Company, Boston, Mass.

Drill.

Neat booklet giving an illustrated summary of the principal features embodied in the new Bickford radial drill. Also, Circular No. 5 on the same subject. Bickford Drill and Tool Company, Cincinnati, Ohio.

Drop Forgings.

Illustrated catalogue of drop forgings for automobiles and motors. Strieby and Foote Co., Newark, N. J.

Dry Kilns.

Catalogue No. 139, with handsome illustrations and descriptions of "A B C" "moist air" and "blower" dry kilns and their applications to lumber drying. American Blower Company, Detroit, Mich.

Dynamos.

Neat and well-illustrated catalogue, No. 2004, of the parts of "Wood" arc dynamos. Fort Wayne Electric Works, Fort Wayne, Indiana.

Electric Machines.

Bulletin No. 141, devoted to multipolar dynamos and electric motors, with illustrations of plants and partial list of users. The C. & C. Electric Company, 143 Liberty Street, New York.

Electric Motors.

Bulletin No. 21, a neat booklet with illustrated descriptions of small electric motors and their application to various power purposes. Crocker-Wheeler Company, Ampère, N. J.

Elevator Motors.

Bulletin No. 132, with well-illustrated descriptions of electric motors for operating elevators. The Holtzer-Cabot Electric Co., Boston (Brookline), Mass.

Fans.

Catalogue No. 140, with handsome illustrations and descriptions of "A B C" disc ventilating fans, and tables of useful information. American Blower Company, Detroit, Mich.

Feed Water.

Neat booklet and two folders, with illustrated descriptions of the Standard feed-water heater, the Berryman feed-water heater and purifier, the Economical feed pump, and the Kelley exhaust pipe head. Benj. F. Kelley & Son, 91 Liberty St., New York.

Foundry Supplies.

Catalogue No. 102, with illustrated descriptions of brushes and brooms of all varieties for foundry and other purposes, and also all kinds of foundry supplies. The Osborn Manufacturing Co., Cleveland, Ohio.

Friction Clutch.

Circular with illustrated description and price list of the Casner Friction Clutch Pulley for gas, gasoline and oil engines. Also, a price list of line shaft friction clutch pulleys. The Casner Pulley Company, Auburn, Indiana.

Gasoline Engines.

A neat pamphlet with well illustrated descriptions of gasoline engines and accessories for boats and vehicles. Daimler Manufacturing Co., Long Island City, N. Y.

Tasteful pamphlet, with very well illustrated descriptions of both two- and four-cycle types of gasoline engines for launches and other boats. Truscott Boat Manufacturing Company, St. Joseph, Michigan.

Gasoline Locomotives.

Illustrated folder showing the Prouty gasoline locomotive and some of its applications, particularly on narrow-gauge mine and industrial railways. Prouty Gasoline Locomotives, Lansing, Michigan.

Gauges.

Illustrated catalogue with descriptions of pressure and vacuum gauges for all purposes, safety valves, thermometers, cocks, etc. Standard Gauge Mfg. Co., Syracuse, N. Y.

Haulage Machinery.

Circular No. 1, Series H A, with well-illustrated descriptions of wire-rope haulage machinery for mining purposes. The Webster, Camp & Lane Co., Akron, Ohio.

Hoisting.

Four circulars, Nos. 1, 2, 3 and 4, Series H O, well illustrated, devoted respectively, to direct-acting hoisting engines, geared hoisting engines, self-contained geared hoists and electrically driven hoists. The Webster, Camp & Lane Co., Akron, Ohio.

Injectors.

Catalogue No. 5 of ball-valve automatic injectors, ejectors, and check valves, with useful information about steam and injectors. Lee Injector Mfg. Co., Detroit, Mich.

Launches.

Book No. 9, with very handsomely illustrated descriptions of launches and gasoline engines. Also a supplementary book of designs (No. 8) of launches and other boats. Lozier Motor Company, Plattsburg, N. Y.

A handsomely and completely illustrated pamphlet describing launches and their complete equipment, gasoline engines, row-boats and canoes; and also folder with testimonials. Truscott Boat Manufacturing Co., St. Joseph, Michigan.

Tasteful pamphlet with handsome illustrations and descriptions of "Alco-Vapor" launches. The Marine Engine & Machine Co., Harrison (Newark), New Jersey.

Light Machine Tools.

Catalogue No. 13, with well-illustrated descriptions of fine machinery for jewelers, watchmakers, dentists, machinists and amateurs. Also folders devoted to double and triple-geared power rolling mills. The W. W. Oliver Manufacturing Company, Buffalo, N. Y.

Locomotives.

Bulletin No. 34, containing a handsomely illustrated record of recent locomotive construction. Baldwin Locomotive Works, Philadelphia, Pa.

A tasteful and handsomely printed pamphlet containing the speeches at the dinner given in commemoration of the completion of the twenty-thousandth locomotive and seventieth year of continuous operation of the Baldwin Locomotive Works, of Philadelphia, Pa.

Lubricators.

Folders describing "up-feed" lubricators, glass oilers, valves and stop cocks. The Wm. Powell Company, Cincinnati, Ohio.

Machinery.

Monthly stock list of new and second-hand boilers, engines, saw mill and wood-working machinery, machine tools, etc. Wickes Brothers, Saginaw, Mich.

Machine Tools.

Pamphlets with illustrated descriptions and prices of drills, tapping machines, grinders and polishing machines. St. Louis Machine Tool Co., St. Louis, Missouri.

Metal Structures.

Attractive, handsomely illustrated pamphlet, with descriptions of water towers, standpipes, stacks, plate girders and bridges. Chicago Bridge and Iron Company, Washington Heights, Chicago, Ill.

Mining Machinery.

A catalogue of hoisting engines, air compressors, pumps and other machinery for mines. Franklin Iron Works, Port Carbon, Pa.

Nuts.

Catalogue and price list of nuts, washers, bolts, screws and clips of all kinds, and also boxwood and ivory rules, with telegraphic code. The Upson Nut Company, Unionville, Conn., and Cleveland, Ohio.

Illustrated catalogue and price list of cold-punched nuts, hot-pressed nuts, washers, bolts, screws and refined bar iron. The Milton Manufacturing Company, Milton, Pa.

Oil Filters.

Neat, illustrated folder devoted to the White Star Oil Filter for purifying lubricating oil. Pittsburgh Gage and Supply Co., Pittsburgh, Pa.

Ore Cars.

Circular No. 1, Series C A, with well illustrated descriptions of ore cars and cages, ore and water buckets, clutches and other hoisting apparatus. The Webster, Camp & Lane Co., Akron, Ohio.

Pipe.

Circulars devoted to cast-iron pipe, Mathews' hydrants, gate valves, hydraulic tools, pumps, gas producer power plants, special castings, etc. R. D. Wood & Co., Philadelphia, Pa.

Pipe Threading.

Illustrated, comprehensive catalogue of pipe-threading machinery and pipe machines of all kinds. D. Saunders' Sons, Yonkers, N. Y.

Portable Drills.

An illustrated circular devoted to portable drills and flexible shafts. Stow Flexible Shaft Co., Frederic Schoff, Proprietor, Philadelphia, Pa.

Pumps.

Advance Sheet No. 15, with illustrated descriptions of pumping machinery for mines. Jeanesville Iron Works Company, Jeanesville, Pa., and Denver, Colo.

Catalogue B, with illustrated description of the Emerson steam vacuum pump and its details, with examples of its application and tables of useful data. Emerson Pump Company, Washington, D. C.

Illustrated catalogue and price list No. 30, 216 pages, of "Red Jacket" hand and power pumps, well supplies, hose, galvanized pipe, etc. Red Jacket Manufacturing Co., Davenport, Iowa.

A well illustrated pamphlet describing the Luitwieler system of pumping and the different styles of "Triumph" pumps, which furnish water in a constant stream. S. W. Luitwieler Company, Los Angeles, Cal.

Pumps and Hay Tools.

Catalogue and price list No. 35, of 323 pages, devoted to pumps for agricultural purposes, haying tools and farm and barn machinery of many kinds. F. E. Myers & Brother, Ashland, Ohio.

Rail Bonds.

Handsome, well-illustrated catalogue of "Crown" and "United States" rail bonds, designed to attain the highest electrical and mechanical efficiency. Also a list of steel products, wire, nails and fencing. American Steel and Wire Co. (Washburn & Moen Department), Chicago, New York, Denver, San Francisco and Worcester, Mass.

Raw-Hide Pinions.

Neat booklet in a convenient wallet, with illustrated description and price list of "new process" noiseless pinions, both spur and bevel, to engage with metal gears. New Process Raw Hide Company, Syracuse, N. Y.

Rubber Goods.

Attractive booklet devoted particularly to packing of all kinds, with references to hose, pump valves and mechanical rubber goods in general. Geo. W. Knowlton Rubber Company, 72 Broad Street, Boston, Mass.

Scrapers.

Catalogue No. 33, devoted to drag and wheel road scrapers, grading plows, dump carts, hand carts, steel sinks, wheelbarrows, etc. The Kilbourne & Jacobs Mfg. Co., Columbus, Ohio.

Screens.

Catalogue No. 69, devoted to screens and screening machinery for all kinds of materials, with partial list of users and testimonials. The Jeffrey Manufacturing Co., Columbus, Ohio.

Shoes and Dies.

Neat and attractively designed illustrated booklet devoted to forged steel shoes and dies for stamp mills, with references to railway equipment and materials for industrial and mining purposes. Arthur Koppel, 66-68 Broad St., New York.

Small Cars.

Catalogue No. 31, devoted to small cars of all kinds, including contractors' dump cars, steel, ore and mine cars and skips, factory, foundry, billet, coal and coke cars, railway hand and push cars, coke buggies, etc. Also two folders. The Kilbourne & Jacobs Mfg. Co., Columbus, Ohio.

Spraying Machines.

Illustrated pamphlet devoted to the Eureka spraying machines, by which com-

pressed air is used for painting, metal lacquering, wood varnishing, foundry purposes, etc. Eureka Pneumatic Spray Company, 556 West 27th St., New York.

Springs.

Catalogue No. 5, devoted to springs of all kinds, with wire gauge table and list of the products of the American Steel and Wire Co. (Washburn & Moen Department), Chicago, New York, Denver, San Francisco, Worcester, Mass.

Steam Accessories.

A handsome, comprehensive catalogue of valves, cocks, gauges, governors, injectors, oil-cups, speed-indicators, and steam fittings of all kinds, and also a variety of hand pumps, with several folders on the same subjects. C. F. Pilz, Chemnitz in Saxony, Germany.

Steam Brass Goods.

Illustrated catalogue and price list No. 7, pocket size, 4th edition, devoted to valves, lubricators, oilers, cocks and steam brass goods and specialties of all kinds. Also two folders. The Wm. Powell Co., Cincinnati, Ohio.

Steam Engines.

Catalogue with well-illustrated descriptions of the "Southern Corliss" steam engines, their details and their foundations, tubular boilers and saw mills. Southern Engine and Boiler Works, Jackson, Tenn.

Circular No. 1, Series E N, with illustrated descriptions of the Akron Corliss steam engines in various styles. The Webster, Camp & Lane Co., Akron, Ohio.

Handsome catalogue of 182 pages, with flexible covers, containing illustrated descriptions of Reynolds Corliss Engines for all purposes, with views of the Edward P. Allis Works, Milwaukee, Wis., and of some of the power plants where these engines are installed. Allis-Chalmers Company, Chicago.

A tasteful and handsomely illustrated pamphlet devoted to Willans steam engines and their manufacture, which is carried on in America exclusively by the Bradley Manufacturing Company, of Pittsburg, Pa.

Storage Batteries.

Bulletin No. 72, showing the application of storage batteries to residential lighting and power plants, with tasteful illustrations of typical installations. Electric Storage Battery Co., Philadelphia, Pa.

Transformers.

Illustrated folder devoted to the S. K. C. Type A. O. (Oil) Lighting Transformers, with some reference to recent transformer litigation. Stanley Electric Manufacturing Company, Pittsfield, Mass.

Instruction Book No. 3008, devoted to "Type A" oil transformers and their installation. Fort Wayne Electric Works Fort Wayne, Indiana.

Tool Holders.

Small circulars, devoted to Storey's tool holders for lathes, planers, and other machines, with sizes and prices. Storey & Sons, Mount Holly, N. J.

Tool Steel.

Neat booklet and folder devoted to "Schoeller" high grade crucible tool steel, particularly "Express" steel, with account of treatment and results of tests. The International Steel and Machinery Co., 245 Centre Street, New York.

Valves.

Illustrated catalogue and price list, with descriptions of steam and water valves in great variety. Roe Stephens Manufacturing Company, Detroit, Michigan.

Very tasteful and handsome pamphlet illustrating the operation of the Chapman water valves by electric motors. This was presented as a souvenir of the Boston Meeting of the American Society of Mechanical Engineers. Chapman Valve Manufacturing Co., Indian Orchard, Mass.

Water Purifying.

An illustrated pamphlet with descriptions of the Dervaux-Reisert automatic water purifying and softening apparatus and filters, with short treatise on water purification, and list of users of the apparatus. Automatic Water Purifying Company, 45 Broadway, New York.

Water Softening.

Neat booklet devoted to water-softening apparatus, of both intermittent and automatic types, for steam plants and all kinds of industrial purposes. New York Continental Jewell Filtration Co., 15 Broad Street, New York.